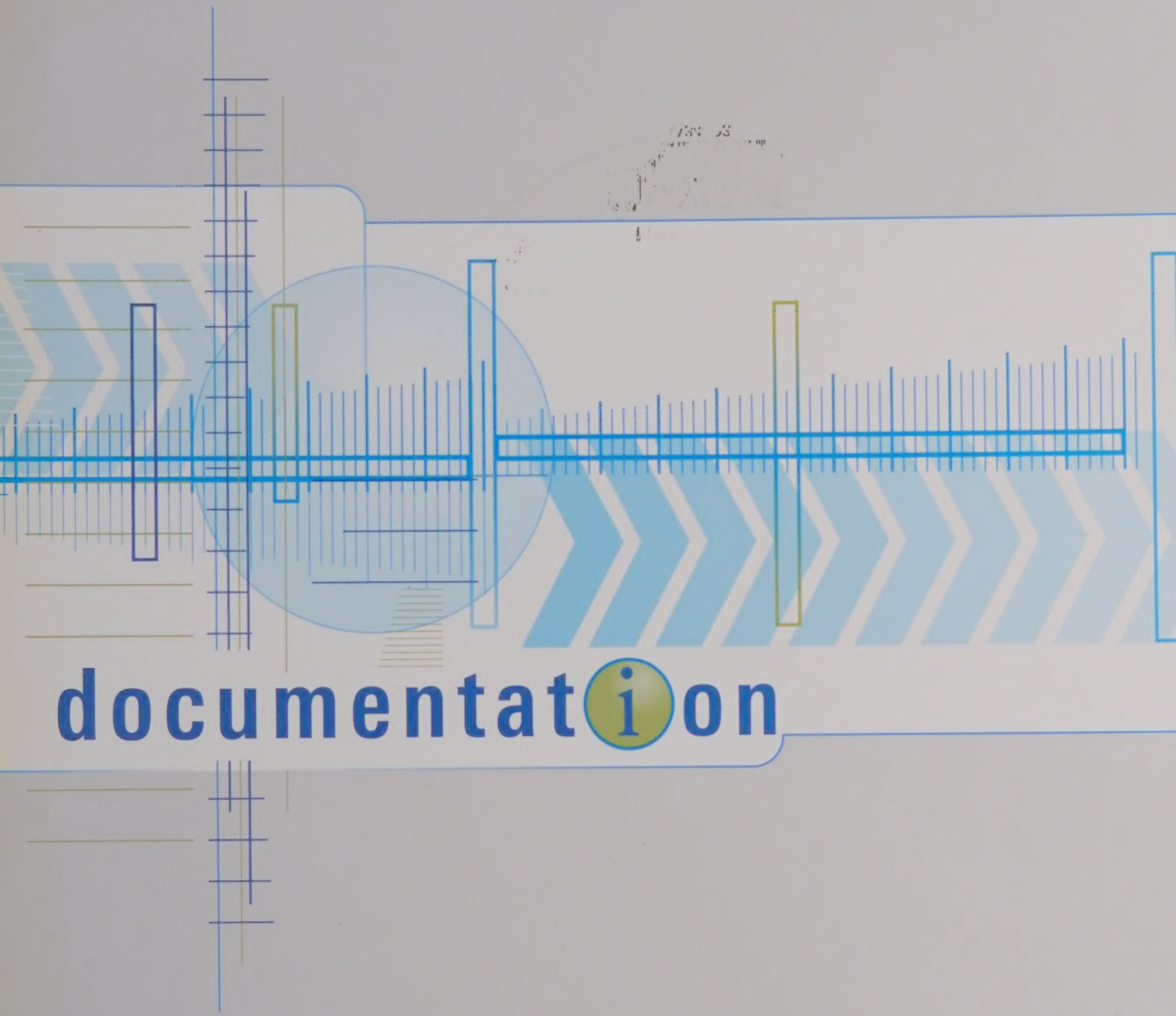

documentation

ROHDE&SCHWARZ

MP MASTER
MA34500

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ROHDE&SCHWARZ

Test and Measurement Division

Manual

Average Power Sensor

R&S® NRP-Z11

10 MHz to 8 GHz / 200 pW to 200 mW

1138.3004.02

R&S® NRP-Z21

10 MHz to 18 GHz / 200 pW to 200 mW

1137.6000.02

Printed in the Federal Republic of Germany

Dear Customer,

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Trade names are trademarks of the owners.

Operation of Power Sensor R&S NRP-Z11 from R&S NRP base unit

The power sensor shipped with this manual has firmware revision ***02.00*** or higher. For operation from an R&S NRP base unit, all software components within the base unit must also be of revision ***02.00*** or higher.

Revision numbers for the software components installed in the base unit can be displayed under menu item 'System Info', lines 'Main Program', 'Bootloader' and 'Keybd. Ctrl.'. The 'System Info' can be found in the 'File' menu for revision numbers lower than 02.00 and in the 'System' menu otherwise.

Tabbed Divider Overview

Data Sheet

Safety Instructions
Certificate of Quality
EU Certificate of Conformity
List of R&S Representatives

Tabbed Divider

1	**Chapter 1:**	**Putting into Operation**
2	**Chapter 2:**	**Virtual Power Meter**
3	**Chapter 3:**	**Operation**
4	**Chapter 4:**	for future extensions
5	**Chapter 5:**	**Remote Control – Basics**
6	**Chapter 6:**	**Remote Control – Commands**
7	**Chapter 7:**	for future extensions
8	**Service Instructions**	

Power Meter R&S NRP

in R&S SMART SENSOR TECHNOLOGY

- Innovative multipath sensor technology
- 90 dB dynamic range
- High measurement speed
- Intelligent sensors – simply plug in and measure
- Accurate measurement of average power regardless of bandwidth and modulation
- Multislot measurements for common time division systems (e.g. GSM/EDGE, DECT)
- Handling of external components through Γ and s-parameter correction
- Simultaneous operation of up to 4 sensors on basic unit
- Operation of sensor directly from PC via USB interface
- 2-year calibration cycle

ROHDE&SCHWARZ

Ready for a wide variety of applications

The RF and microwave Power Meter R&S NRP is always the right choice: It is ideal for daily use in research and development, production or mobile service, not to mention when analyzing broadband modulation signals of third-generation mobile radio. The versatility of the novel R&S NRP power meter series is primarily due to the newly developed sensors in R&S SMART SENSOR TECHNOLOGY. These sensors are intelligent standalone instruments that communicate with the basic unit or a PC via a digital interface. The R&S SMART SENSOR TECHNOLOGY, now implemented for the first time, sets new standards in terms of universality and accuracy. The R&S NRP basic unit offers exactly what you expect for today's needs: compact size, intuitive user interface and multichannel capability.

Designed for R&D

Top measurement accuracy plus a dynamic range of 90 dB for broadband signals of any modulation are the most requested characteristics of a modern power meter. The versatile R&S NRP sensors in R&S SMART SENSOR TECHNOLOGY feature exactly these characteristics and are a priceless investment if you wish to meet future requirements such as the broadband modulation types of third-generation mobile radio. In addition, they are also capable of handling the RF bandwidths beyond 100 MHz that are already under discussion for wireless LAN.

A power meter must of course be easy to operate: The numerous sensor functions can be activated via an intuitive user interface, and the high-resolution display indicates up to 4 measurement results at a time. As with other power meters from Rohde&Schwarz, all calibration data is stored in the sensor, which ensures high-precision measurements by minimizing operating errors.

Softkeys and window-oriented menu technique
Power sensor in R&S SMART SENSOR TECHNOLOGY with 90 dB dynamic range
Built-in test generator (option R&S NRP-B1)
Display of up to 4 measurement results
Function keys for fast access to important functions
Sensor connectors on front panel, channel B: option R&S NRP-B2
ROHDE&SCHWARZ
NRP - POWER METER
-20.92 dBm
0.41 dB
NRP-Z21

Ideal for production

If you have ever dealt with microwave power measurements, you know that the necessary filtering of results due to the noise characteristics of the sensor as well as delays in measurement range selection and command/result processing can have negative effects on throughput in production. And this is where the R&S NRP with its innovative features offers straightforward solutions:

- Autofilter
- Parallel processing
- Speed

It goes without saying that the basic unit, which can accommodate up to 4 sensors at the same time, can be fully remote-controlled. In addition, the sensors can directly be connected to a PC. It is good to know that the sensors can perform reliable measurements for an extended period of time owing to the long calibration interval of 2 years.

Mobile use

The handy, lightweight and sturdy instrument, which can also be powered from the optional battery for several hours, makes mobile use a pleasure. With an operating temperature range from 0 °C to 50 °C, the Power Meter R&S NRP can be used under almost any conditions.

R&S SMART SENSOR TECHNOLOGY allows every R&S NRP sensor to be operated directly from a PC, making it the smallest and most lightweight microwave measuring instrument available.

For any type of test signal:

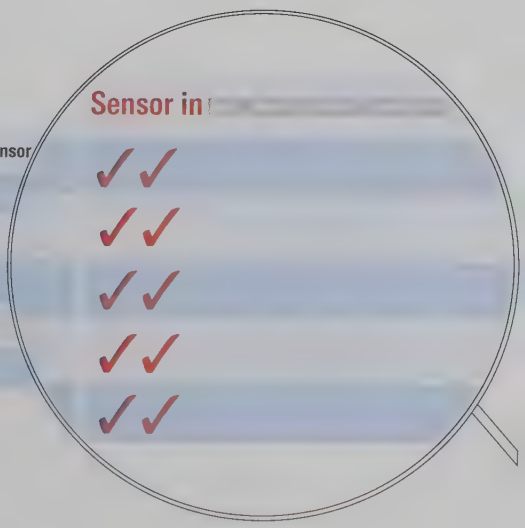
R&S SMART SENSOR TECHNOLOGY

Microwave power meters have historically required a multitude of different sensors to cover all applications. Thermal sensors, diode sensors as well as peak power sensors were used to handle the various measurement tasks. The sensors of the R&S NRP family now make life much easier – in many cases, a single sensor can perform all necessary measurements (see table 1).

Table 1: Sensor technologies and their applications

Application ↓ Sensor →	Thermoelectric sensor	Diode sensor (CW)	Peak power sensor
Average power	✓✓	✓	✓
Burst power	—	—	✓✓
Time gating	—	—	✓✓
Signal with extremely high bandwidth	✓✓	✓	—
Measurement over wide dynamic range	—	✓✓	✓

✓✓ optimal ✓ possible — not possible



Summary

- **One** power sensor
- 90 dB dynamic range
- CW **and** broadband-modulated signals
- Time-gating applications
- High measurement accuracy and speed

High system accuracy through R&S SMART SENSOR TECHNOLOGY

Plug in and measure

The accuracy of microwave power measurements essentially depends on the characteristics of the sensor, but it is impossible to eliminate level, temperature and frequency influences by traditional means. Rohde&Schwarz solved this problem years ago by introducing a novel approach: Measure the deviations of each manufactured sensor from the ideal characteristics and then store the values in the sensor as a data record. This means that you do not have to bother with calibration data. Instead, you simply plug in the sensor and start the measurement, which is a significant advantage in day-to-day work.

High measurement accuracy – even with modulated signals

Benefitting from all the factors described above, Rohde&Schwarz broadband power meters have a very low measurement uncertainty, which is still the decisive argument in their favour. In the past, however, the data sheet specifications of about 2% (0.09 dB) could seldom be achieved in practice. This was due to error sources associated with the test signal or external circuitry: harmonics and nonharmonics, modulation, mismatch of the source, and the influence of attenuators and directional couplers connected ahead of the sensor for level matching.

The R&S NRP sensors represent a big step forward in solving these problems. The concept of R&S SMART SENSOR TECHNOLOGY (see page 5) comprises an entire series of measures intended to make the sensors similar to thermal sensors in behaviour. This includes very accurate measurement of average power, regardless of modulation (FIG 1), as well as high immunity to incorrect weighting of harmonics, spurious and other interference signals. The maximum speed of 1500 measurements per second (in buffered mode, measurement interval 2 x 100 µs) nevertheless equals that of diode sensors.

Precise calibration

A power sensor can only be as good as the measuring instruments used to calibrate it. This is why the standards employed by Rohde&Schwarz are directly traceable to the power standards of the German Standards Laboratory (PTB).

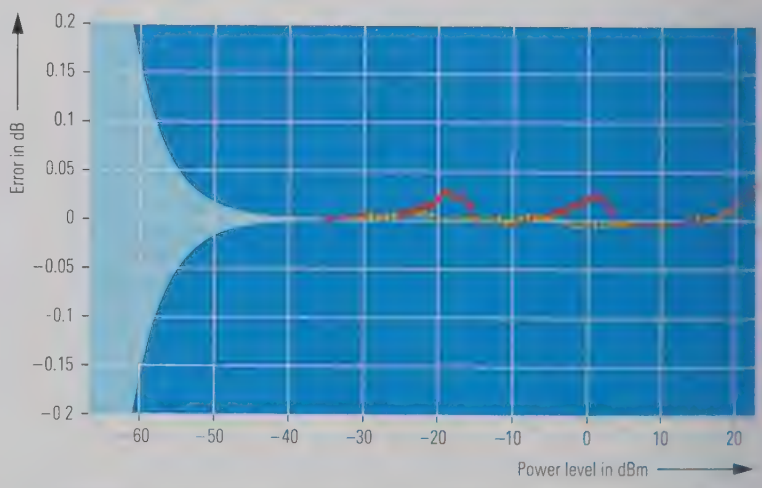


FIG 1: Modulation-related errors of an R&S NRP-Z11 or R&S NRP-Z21 power sensor for a 3GPP test signal (test model 1-64) compared to a CW signal of the same magnitude.
Red: default setting; yellow: transition area between measurement paths shifted by –6 dB; light blue: uncertainty caused by noise (modulation effect below –30 dBm negligible).

R&S SMART SENSOR TECHNOLOGY

The Power Sensors R&S NRP-Z11 and R&S NRP-Z21 fuse multiple-path architecture, multiple-diode technology and a simultaneously scanning multichannel measurement system into a unique high-performance concept.

Multiple-path architecture is the combination of two or three diode detectors to obtain a large dynamic range for modulated signals. This is achieved by operating each detector exclusively in the square-law region and by using only the optimally driven detectors for the measurement.

Multiple diodes comprise several zero-bias Schottky diodes connected in series and integrated on one chip. When used in an RF detector, they expand its square-law region, because the measurement voltage is split among several diodes – so that each one is driven less – while at the same time the detected voltages of the individual diodes are added together.

Rohde&Schwarz's multiple-path architecture (patent pending) is characterized by the following features (FIG 2):

- 3 signal paths, each fitted with triple diodes
- 6 dB wide overlap ranges, smooth transitions
- Simultaneous scanning and analysis
- Chopper stabilization of signal paths for recurring signals

The advantages over conventional technology are obvious: high signal/noise ratio throughout, low modulation effect, negligible delays and discontinuities when switching signal paths, as well as the ability to perform a time-domain analysis of the test signal within the available video bandwidth.

As a consequence, these sensors not only compete with peak power meters – they are indeed superior in two respects:

- No restrictions on the RF bandwidth of the test signal
- Wider dynamic range

As a result, it is already possible today to analyze extremely broadband signals, such as are planned for wireless LAN or will be created by combining several carriers in accordance with 3GPP.

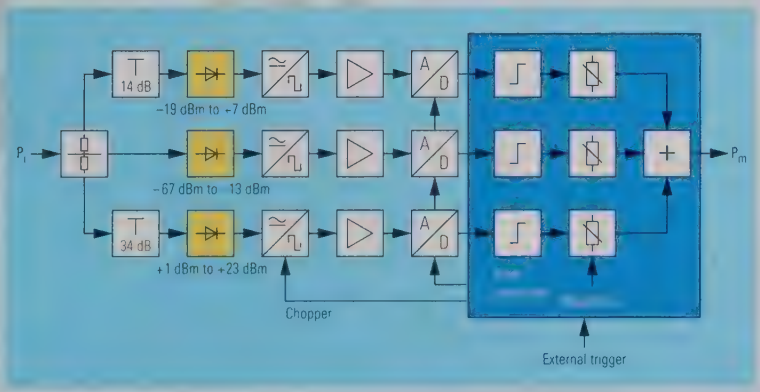


FIG 2: Sensor architecture in R&S NRP-Z11 and R&S NRP-Z21.

Power measurement without external influences

Γ correction – accounting for the source mismatch

The most important source of error in power measurements on RF and microwave signals is the mismatch of source and sensor. Due to reflections that cannot be eliminated, it is not the nominal power P_{GZ0} of the source that is transmitted to the power sensor, but the power P_i (FIG 3) that deviates to a certain extent from the nominal value. To minimize the influence of mismatched sources, the standing wave ratio (SWR) at the sensor end was reduced to the extent technically feasible (1.11). However, a signal source with an SWR of 2, for example, still leads to an additional uncertainty of the measurement result of ±3.5% (0.15 dB). Although this error normally is decisive for total measurement uncertainty, it was frequently not taken into account because it could not be specified for the sensor alone.

Here the R&S NRP sensors boast another innovation: To reduce the mismatch, the complex reflection coefficient of the source is transmitted to the sensor via the USB data interface, and the sensor corrects the matching error by means of Γ correction, taking into consideration its own low impedance mismatch. This approach yields a measurement result of significantly higher precision.

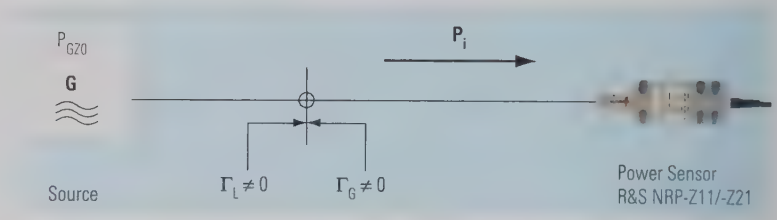


FIG 3: Γ correction function: By taking into account the complex reflection coefficient Γ_G of the source, the measurement result (P_i) is corrected in such a way that the nominal power of the source P_{GZ0} is displayed.

S-parameter correction – accounting for additional components

A similar mismatch problem is encountered in test setups where the sensor cannot be connected directly to the source to be measured. Especially in production facilities, it is often necessary to connect a cable or an attenuator for level matching. In this case, the interactions between three components must be taken into account – a non-trivial bit of mathematics involving complex numbers.

Here, too, the R&S NRP offers a straightforward, standardized solution to the user. With the help of a small software tool that runs on any PC, the complete s-parameter data set of the twoport connected ahead can be loaded into the sensor's memory via the USB data interface.

The data format required (s2p/Touchstone) is provided by any vector network analyzer.

After the source's complex reflection coefficient has been transmitted (optionally), a perfectly corrected reading is obtained; the sensor practically behaves as if it were connected directly to the source (FIG 4).

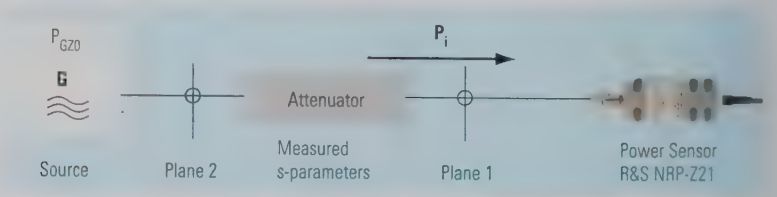


FIG 4: Shifting the measurement plane from 1 to 2 by means of s-parameter correction. The influence of the additional component is compensated for, so that the nominal power P_{GZ0} of the source is measured.

Throughput is essential in production

New autofilter function – averaging made simple

The setting of the display filter is essential for the measurement speed that can be attained. As a rule, noise is superimposed on the signal to be measured. The relative noise content increases as power decreases. To obtain a noise-reduced display, an averaging factor has to be selected for low signal levels, but such a factor increases the measurement time. Therefore a compromise must be made between sufficient signal/noise ratio and acceptable measurement time. The following rule of thumb applies: Reducing the noise by a factor of 10 increases the measurement time by a factor of 100. With the classic autofilter function, the averaging factor is, therefore, only increased gradually, which keeps the measurement time acceptable but does not make it possible to maintain a specific noise level.

The enhanced autofilter function, now implemented in a power meter for the first time, mitigates this problem. In addition to the classic autofilter function, a Fixed Noise mode is available. Using this mode, the sensor will maintain the user-defined S/N ratio as long as the maximum measurement time (to be defined by the user) is not exceeded. Consequently, the instrument provides stable measurement results exactly matched to the user's needs.

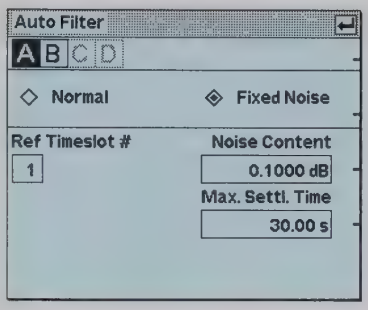


FIG 5: Autofilter menu of the R&S NRP.

Measurement range selection without delay

Multipath concepts for diode sensors often have the disadvantage of hard switching from path A to path B in the case of level changes, which interrupts measurement data acquisition and introduces large differential linearity errors. This disadvantage has been eliminated in the R&S NRP diode sensors in R&S SMART SENSOR TECHNOLOGY owing to parallel signal processing in the three paths and soft transitions from one path to the other.

User-definable measurement window

Measurements on very low-frequency-modulated signals are typically performed using large averaging factors to keep the display stable. This, however, extends the measurement time. The R&S NRP uses a different approach: The measurement time interval is adapted to the signal period by means of windowing. The use of an integer multiple of the period yields a perfectly stabilized measurement result.

High measurement speed

All these requirements, i.e. optimum filtering and fast range selection, must be met before a power meter can make full use of its measurement speed under any conditions. If filtering is not necessary and the size of the measurement window is not critical, the R&S NRP excels with its 1500 measurements per second (in buffered mode, measurement interval 2 x 100 µs).

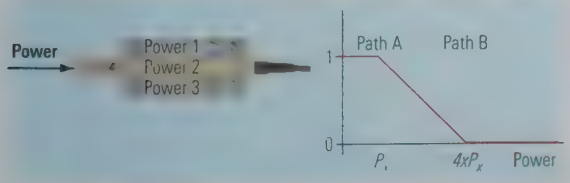


FIG 6: Parallel signal processing and soft transitions between measurement paths owing to R&S SMART SENSOR TECHNOLOGY

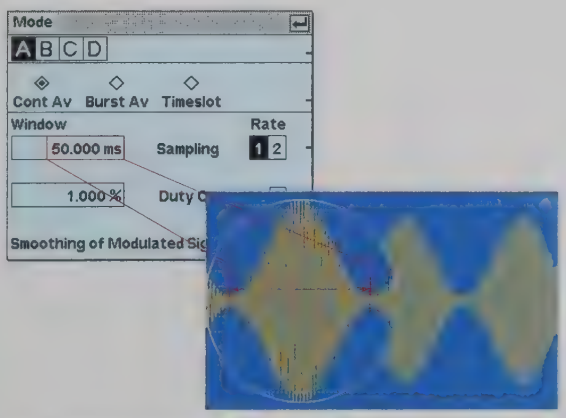


FIG 7: Windowing technique used on a low-frequency-modulated signal.

Signal-synchronized measurements

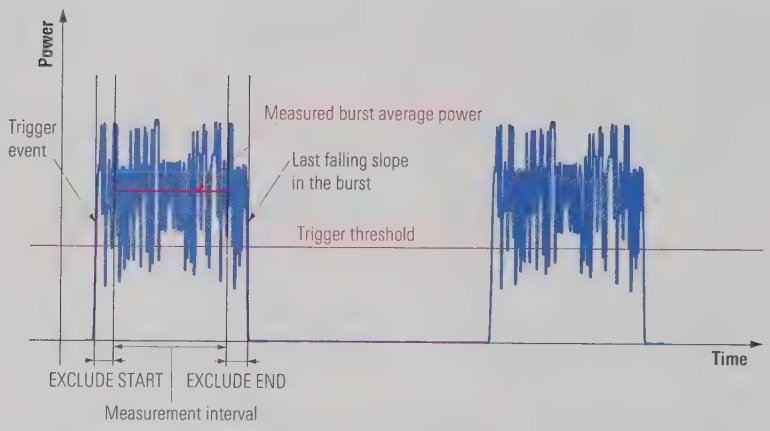


FIG 8: Modulated burst of an EDGE signal and relevant parameters for measuring burst average power.

Just in time

The R&S NRP-Z11 and R&S NRP-Z21 sensors can measure the average power not only in the classic manner, i.e. continuously without temporal reference to the signal content, but also synchronized with the signal over definable periods of time. Power measurements on signal bursts and within individual timeslots of time division systems are important applications. A fundamental prerequisite for signal-synchronized measurements is the availability of extensive trigger capabilities. The Power Meter R&S NRP can derive the trigger time from the test signal (internal triggering) or from an external trigger signal.

Automatic burst acquisition and measurement

The internal trigger capabilities of the Power Meter R&S NRP are particularly useful for burst measurements. Depending on the trigger level previously defined, the sensor automatically determines the beginning and the end of the burst. This is even accomplished for modulated bursts by defining of a dropout parameter, i.e. a minimum signal-off period that must be detected by the sensor to reliably determine the end of the burst.

In addition, unwanted power components at the beginning or end of the burst can be excluded from the displayed result by using the commands EXCLUDE START and EXCLUDE END (FIG 8).

Multislot measurements

This function enables the R&S NRP to carry out measurements on signals with complex timeslot structure. Up to 128 intervals (26 when controlled by the basic unit) can be acquired and measured at the same time (FIG 9). This allows entire frames of GSM/EDGE signals to be analyzed. The user can select the number and the timing of the timeslots relative to the trigger event; up to 4 results can simultaneously be displayed on the basic unit. The unwanted portions in the transition from one timeslot to the next can be blanked by user-definable exclusion periods.

The internal trigger capabilities of the R&S NRP can also be used in this context. In the case of TDMA signals, using an external frame trigger is often beneficial to generate the temporal relation to timeslot 1. The basic unit is fitted with the appropriate connector on the rear panel; if the sensor is operated from a PC, triggering via the Adapter R&S NRP-Z3 is possible.

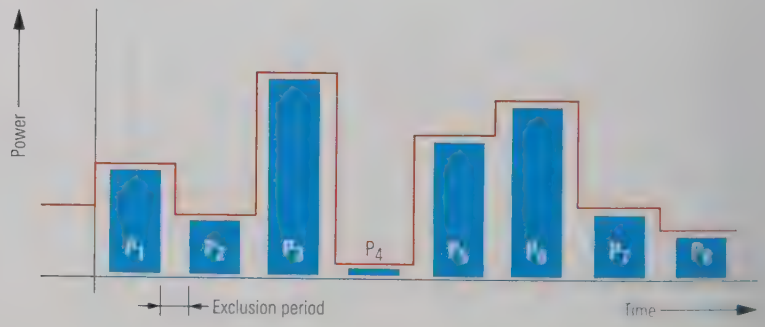


FIG 9: Multislot measurement: for the most common time division methods (e.g. GSM/EDGE, DECT), average power can be measured in all timeslots at the same time.

Power/time template

If the R&S NRP-Z sensors are operated from a PC (see page 10), more in-depth analysis functions are available. Recurring or non-recurring waveforms can be displayed as power/time templates (FIG 10). The number of test intervals (points) can be increased to 1024; signal details down to a duration of about 10 µs can thus be resolved. Extensive trigger functions, derived from an external source or the test signal, again ensure stable conditions.

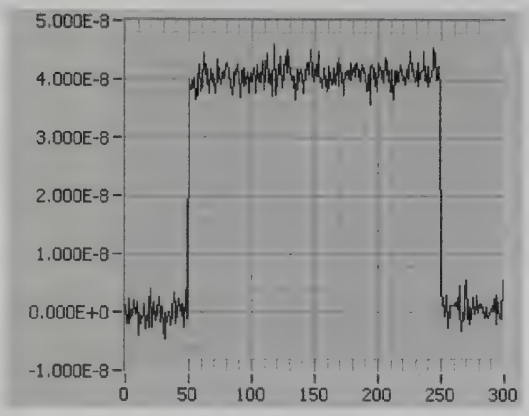


FIG 10: Power/time template of a nonrecurring RF burst for an application in medical electronics, measured with the R&S NRP-Z11 (LabView application without basic unit; readings in W and ms, no averaging).

Outstanding dynamic range

In the past, the limited dynamic range of standard sensor technologies forced many users to employ sensors of different sensitivity (nominal power) to handle the power range of the test items. This was especially true if average power of modulated signals had to be measured. Although conventional multipath sensors were able to attain respectable values, their dynamic range was limited to 80 dB, not to mention the slow response times and the significant measurement errors in the transition regions of the individual paths. The R&S NRP-Z11 and R&S NRP-Z21 are the first sensors with outstanding values: For the first time, a dynamic range of 90 dB for broadband signals of any modulation has been achieved, while the lower measurement limit (defined by noise and zero offset) remains a very respectable –67 dBm. With signal-synchronized measurements, the difference between the new sensors and previous power sensors is most evident.

For signal-triggered measurements of the average power of single bursts or the generation of a power/time template, a wider dynamic range is available than with all existing conventional designs.

Table 2: Dynamic range for measuring average power (bandwidth of test signal 100 MHz/5 MHz/0 (CW))

Technology ↓	Mode ↓			
	Continuous	**Timeslot** 1 out of 8 (external trigger)	**Burst** duty cycle 1:8 (internal trigger)	**Power versus time** 256 points (external trigger)
Thermoelectric sensor	50/50/50 dB	–	–	–
Diode: Sensor in square-law region	43/43/50 dB	–	–	–
Diode: CW sensor	43/43/90 dB	–	–	–
Diode: Peak sensor	33/50/80 dB	–/50/57 dB	–/33/37 dB	–/50/57 dB
Diode: Multiple-path sensor	80/80/80 dB	–	–	–
Diode:	**90/90/90 dB**	**85/85/85 dB**	**60/60/60 dB**	**70/70/70 dB**

Sensor with PC interface

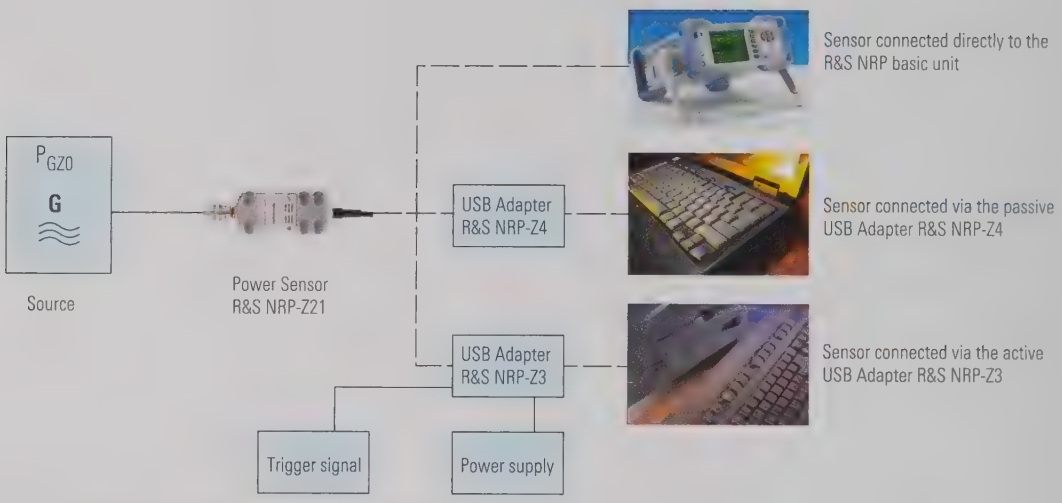

Sensor connected directly to the R&S NRP basic unit
P_{GZ0}
G
Source
Power Sensor R&S NRP-Z21
USB Adapter R&S NRP-Z4
Sensor connected via the passive USB Adapter R&S NRP-Z4
USB Adapter R&S NRP-Z3
Sensor connected via the active USB Adapter R&S NRP-Z3
Trigger signal
Power supply

FIG 11: Three ways of displaying results with an R&S NRP sensor.

Miniature power meter

The sensors of the R&S NRP-Z series can be used as standalone measuring instruments without the basic unit. In addition to the power sensor itself, they include a CPU that controls the sensor, processes the measurement results and operates the interface: a complete miniature power meter. All measurement data and settings are transmitted via a digital USB interface. This concept, with which Rohde&Schwarz already set the pace in the field of directional power meters, is now being used for the first time in classic microwave power measurements.

Use on a PC

The most cost-effective method for high-precision power measurements is to connect the sensors directly to a PC, especially if data acquisition and evaluation take place via a PC. The main area of application is production, since production environments usually include a process controller. The fact that the basic unit can be omitted saves space in the rack and reduces costs.

Service technicians will also appreciate this option since the power meter fits into a trouser pocket and can easily be operated from a laptop.

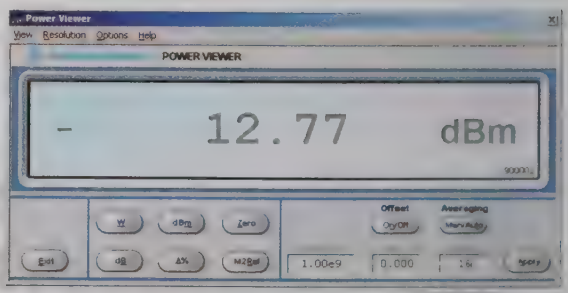


FIG 12: The Power Viewer turns any PC (under Windows 98/2000/ME/XP) into a power meter.

The software toolkit supplied as standard with every R&S NRP sensor is required in order to control the R&S NRP power sensors via a PC. The software toolkit comes with both a DLL (dynamic link library), for individualized use of the entire sensor functionality under Windows, and the Power Viewer, a virtual power meter with basic measurement functions (subset of the R&S NRP functionality) for the PC workstation (FIG 12).

Two adapters are available for connection to the hardware:

- The passive USB Adapter R&S NRP-Z4 provides all basic functions, as it handles the transmission of settings and measurement data as well as the power supply of the sensor.
- The active USB Adapter R&S NRP-Z3 has been developed for applications requiring external triggering of the power sensor. It also offers a separate power supply.

Universal basic unit

For applications requiring a basic unit, the R&S NRP offers everything that is expected from a modern power meter – and much more. It is small, lightweight and rugged, and the optional battery pack ensures several hours of operation without line power. Depending on requirements, it can be fitted with one, two or four measurement inputs (options R&S NRP-B2 and R&S NRP-B5).
The IEC/IEEE bus connector is a standard feature as are the trigger input and the analog measurement output.

The user interface of the power meter takes its cue from the PC world: The basic unit is controlled via menu bars, menus and dialog boxes, and uses only three menu levels despite the large number of functions. The self-explanatory operating concept makes the R&S NRP a pleasure to use.

The high-resolution graphical display can show as many as four measurement results at the same time. The user can choose which results to display – either the data from different sensors (with a maximum of four connected simultaneously) or from different timeslots of a TDMA signal measured by means of one sensor. Even values obtained by calculation, such as SWR or return loss, can be displayed. For immediate clarity, each data window can be assigned a specific name.

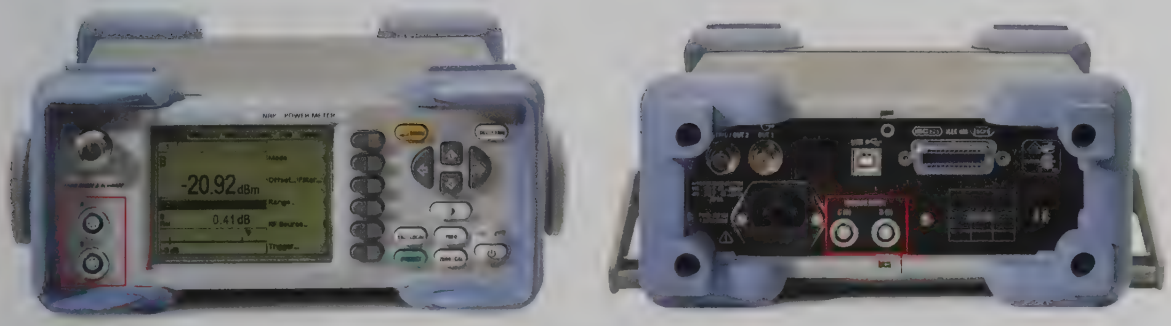


FIG 13: The Power Meter R&S NRP can be equipped with one, two or four measurement inputs (two on rear panel, see red frame).

Specifications

Power Sensors R&S NRP-Z11/-Z21 (specifications from 8 GHz to 18 GHz apply only to R&S NRP-Z21)

Bold: Parameter 100% tested.
Italics: Uncertainties calculated from the test assembly specifications and the modelled behaviour of the sensor.
Normal: Compliance with specifications is ensured by the design or derived from the measurement of related parameters.

Sensor type	3-path diode sensor
Measurand	average power of incident wave or average power of source into 50 Ω[1]
Frequency range	10 MHz to 8 GHz (R&S NRP-Z11) 10 MHz to 18 GHz (R&S NRP-Z21)
Matching (SWR)	values in () for temperature range 15 °C to 35 °C
10 MHz to <30 MHz	<1.15 **(1.13)**
30 MHz to 2.4 GHz	<1.13 **(1.11)**
>2.4 GHz to 8.0 GHz	<1.20 **(1.18)**
>8.0 GHz to 18.0 GHz	<1.25 **(1.23)**
Level-dependent matching change[2]	
10 MHz to 2.4 GHz	<0.05 (0.02)
>2.4 GHz to 18.0 GHz	<0.10 (0.07)
RF connector	N (male)
Power measurement range	
Continuous Average	200 pW to 200 mW (–67 dBm to +23 dBm)
Burst Average	200 nW to 200 mW (–37 dBm to +23 dBm)
Timeslot	650 pW to 200 mW (–62 dBm to +23 dBm)[3]
Scope	10 nW to 200 mW (–50 dBm to +23 dBm)[4]
Max. power	
Average	0.4 W (+26 dBm) continuous
Peak envelope power	1.0 W (+30 dBm) for max. 10 µs
Measurement subranges	
Path 1	–67 dBm to –14 dBm
Path 2	–47 dBm to + 6 dBm
Path 3	–27 dBm to +23 dBm
Transition ranges	
With automatic path selection, user def'd crossover[5] set to 0 dB	(–19 ±1) dBm to (–13 ±1) dBm (+1 ±1) dBm to (+7 ±1) dBm
Measurement functions	
Stationary and periodically modulated signals	Continuous Average Burst Average Timeslot Scope[6]
Non-recurring waveforms	Scope[6]
Continuous Average function	
Continuous measurement of average power	
Measurement window[7]	2 x (10 µs to 300 ms)
Duty cycle correction[8]	0.001% to 100.00%
Smoothing	see under Measurement window (page 13)
Capacity of measurement buffer[9]	1 to 1024 results
Burst Average function	
Measurement of average burst power with automatic detection of burst (trigger settings required)	
Detectable burst width	20 µs to 100 ms
Minimum gap between bursts	10 µs
Dropout tolerance[10]	0 ms to 3 ms
Exclusion periods[11]	
Excluded from Start	0 ms to 100 ms
Excluded from End	0 ms to 3 ms
Measurement window[7]	2 x (burst width – Excl. from Start – Excl. from End)
Timeslot function	
Measurement of average power in one or more equidistant, successive timeslots	
Duration (nominal width)	10 µs to 100 ms
Number of timeslots	1 to 128 (26 in case of operation from R&S NRP basic unit)
Exclusion periods[11]	
Excluded from Start	0 ms to 100 ms
Excluded from End	0 ms to 3 ms
Measurement window (per timeslot)[7]	2 x (nom. width – Excl. from Start – Excl. from End)
Scope function	
Measurement of power versus time	
Modes	for recurring and non-recurring waveforms (single)
Measurement window Δ[12]	
Recurring	2 x (100 µs to 300 ms)
Non-recurring	100 µs to 300 ms
Number of measurement points M	1 to 1024
Resolution Δ/M	≥10 µs
Beginning of measurement window (referenced to trigger)	–5 ms to 100 s
Dynamic behaviour of video path	values in () for temperature range 15 °C to 35 °C
Bandwidth	>50 kHz (100 kHz)
Rise time 10%/90%	<8 µs (4 µs)
Sampling frequencies	
Frequency 1 (default)	133.358 kHz
Frequency 2[13]	119.467 kHz
Display noise[14]	values in []: 8 GHz to 18 GHz
15 °C to 35 °C Path 1	<60 pW [64 pW] (40 pW typ.)
Path 2	<5.6 nW [6.0 nW] (3.6 nW typ.)
Path 3	<0.56 µW [0.60 µW] (0.36 µW typ.)
0 °C to 50 °C Path 1	<65 pW [69 pW]
Path 2	<6.3 nW [6.6 nW]
Path 3	<0.63 µW [0.66 µW]
Display noise, relative[15]	
Measurement window 2 x 100 µs, without averaging	<0.160 dB (0.1 dB typ.)
Measurement window 2 x 20 ms, averaging factor 32 (measurement time approx. 1 s)	<0.002 dB (0.001 dB typ.)
Zeroing (duration)	
Depends on setting of averaging filter	
AUTO ON	4 s
AUTO OFF	
Integration time[16] <4 s	4 s
4 s to 16 s	integration time[16]
>16 s	16 s

Zero offset[17]

values in []: 8 GHz to 18 GHz

15 °C to 35 °C	Path 1	<96 pW [102 pW] (64 pW typ.)
	Path 2	<9.0 nW [9.6 nW] (5.8 nW typ.)
	Path 3	<0.90 µW [0.96 µW] (0.58 µW typ.)
0 °C to 50 °C	Path 1	<104 pW [110 pW]
	Path 2	<10.0 nW [10.6 nW]
	Path 3	<1.00 µW [1.06 µW]

Zero drift[18]

values in []: 8 GHz to 18 GHz

Path 1	<35 pW [37 pW]
Path 2	<3.0 nW [3.2 nW]
Path 3	<0.30 µW [0.32 µW]

Measurement error due to harmonics $n \times f_0$ of carrier frequency[19]

Values in []: typ. standard uncertainty

n = 3, 5, 7, ...[20]	–30 dBc	<0.003 dB [0.0015 dB]
	–20 dBc	<0.010 dB [0.005 dB]
	–10 dBc	<0.040 dB [0.015 dB]
n = 2, 4, 6, ...[20]	–30 dBc	<0.001 dB [0.0003 dB]
	–20 dBc	<0.002 dB [0.001 dB]
	–10 dBc	<0.010 dB [0.003 dB]

Modulation influence[21]

values in []:
User def'd crossover ≤–6 dB

General	measurement errors in subranges are proportional to power and depend on CCDF and modulation bandwidth of test signal
WCDMA (3-GPP Test Model 1-64)	
Worst case	–0.02 dB to +0.07 dB [–0.02 dB to +0.02 dB]
Typical	–0.01 dB to +0.03 dB [–0.01 dB to +0.01 dB]

Averaging filter

Modes	AUTO OFF (fixed averaging factor) AUTO ON (continuously auto-adapted) AUTO ONCE (automatically fixed once)
AUTO mode	
Reference power	
Continuous Average	non-averaged result in measurement window
Burst Average	non-averaged result in measurement window
Timeslot	non-averaged result in reference timeslot[25]
Scope[22]	non-averaged result at reference point[25]
Normal operating mode[23]	setting of filter depends on power to be measured and resolution
Resolution	1 (1 dB), 2 (0.1 dB), 3 (0.01 dB), 4 (0.001 dB)
Fixed Noise operating mode	filter set to specified noise content
Noise content	0.0001 dB to 1 dB
Max. measurement time[24]	0.01 s to 999 s
Averaging factor N	1 to 2^{16} (number of averaged measurement windows)
Result output	
Moving Average	continuous with every newly evaluated measurement window (e.g. in case of manual operation via R&S NRP)
Repeat	only final result (e.g. in case of remote control of R&S NRP)

Measurement window

Duration	as specified for the individual measurement functions
Shape	rectangular (integrating behaviour; available for all measurement functions) Von Hann (smoothing filter, for efficient suppression of result variations due to modulation[26]; only for Continuous Average function)

Measurement times[27]

Continuous Average	N x (duration of measurement window[7] + 0.2 ms) + t_z
Buffered, without averaging	buffer size x (duration of measurement window[7] + 0.5 ms) + t_z
Burst Average	(2 to 4) x N x burst period + t_z
Timeslot, Scope	(2 to 4) x N x trigger period + t_z[28] t_z: <1.6 ms (0.9 ms on average)

Triggering

Source	Bus, External, Hold, Immediate, Internal
Slope (external, internal)	pos./neg.
Level	
Internal	–40 dBm to +23 dBm
External	see specs of R&S NRP and USB Adapter R&S NRP-Z3
Delay	–5 ms to +100 s
Holdoff	0 s to 10 s
Hysteresis	0 dB to 10 dB

Attenuation correction

Function	correcting the measurement result by means of a fixed factor (dB offset)
Range	–100.000 dB to +100.000 dB

S-parameter correction

Function	taking into account a component connected ahead of the sensor by loading its s-parameter data set into the sensor
Number of frequencies	1 to 1000
Parameters	s_{11}, s_{21}, s_{12} and s_{22} (in s2p format)
Download	with R&S NRP toolkit (supplied with sensor) via USB Adapter R&S NRP-Z3 or R&S NRP-Z4

Γ correction

Function	reducing the influence of mismatched sources[29]
Parameters	magnitude and phase of reflection coefficient of source
Download	see under S-parameter correction

Frequency response correction

Function	taking into account the calibration factors relevant for the test frequency
Parameter	carrier frequency (center frequency)
Permissible deviation from actual value	50 MHz (0.05 x f below 1 GHz) for specified measurement uncertainty

Interface to host

Power supply	+5 V/200 mA typ. (USB high-power device)
Remote control	as a USB device (function) in full-speed mode, compatible with USB 1.0/1.1/2.0 specifications
Trigger input	differential (0/+3.3 V)
Dimensions (W x H x L)	48 mm x 31 mm x 170 mm length incl. connecting cable: approx. 1.6 m
Weight	<0.3 kg

Calibration uncertainty[30] in dB

10 MHz to <20 MHz			20 MHz to <100 MHz			
Path 1	Path 2	Path 3	Path 1	Path 2	Path 3	
0.056	*0.047*	*0.048*	*0.056*	*0.047*	*0.047*	20 °C to 25 °C
100 MHz to 4 GHz			**>4 GHz to 8 GHz**			
Path 1	Path 2	Path 3	Path 1	Path 2	Path 3	
0.066	*0.057*	*0.057*	*0.083*	*0.071*	*0.072*	20 °C to 25 °C
>8 GHz to 12.4 GHz			**>12.4 GHz to 18 GHz**			
Path 1	Path 2	Path 3	Path 1	Path 2	Path 3	
0.094	*0.076*	*0.076*	*0.123*	*0.099*	*0.099*	20 °C to 25 °C

Uncertainty for absolute power measurements[31] in dB

10 MHz to <20 MHz			20 MHz to <100 MHz			
0.174	*0.175*	*0.175*	*0.147*	*0.159*	*0.159*	0 °C to 50 °C
0.075	*0.070*	*0.071*	*0.072*	*0.069*	*0.069*	15 °C to 35 °C
0.056	*0.047*	*0.048*	*0.056*	*0.047*	*0.048*	20 °C to 25 °C
–40 to –19 (–67)	to	+1 to +23	–40 to –19 (–67)	to	+1 to +23	dBm
100 MHz to 4 GHz			**>4 GHz to 8 GHz**			
0.150	*0.162*	*0.164*	*0.160*	*0.170*	*0.174*	0 °C to 50 °C
0.081	*0.077*	*0.081*	*0.096*	*0.089*	*0.097*	15 °C to 35 °C
0.066	*0.058*	*0.063*	*0.083*	*0.072*	*0.082*	20 °C to 25 °C
–40 to –19 (–67)	to	+1 to +23	–40 to –19 (–67)	to	+1 to +23	dBm
>8 GHz to 12.4 GHz			**>12.4 GHz to 18 GHz**			
0.168	*0.176*	*0.184*	*0.188*	*0.196*	*0.210*	0 °C to 50 °C
0.106	*0.096*	*0.110*	*0.133*	*0.120*	*0.142*	15 °C to 35 °C
0.094	*0.079*	*0.096*	*0.123*	*0.103*	*0.128*	20 °C to 25 °C
–40 to –19 (–67)	to	+1 to +23	–40 to –19 (–67)	to	+1 to +23	dBm

Uncertainty for relative power measurements[32][33] in dB

10 MHz to <20 MHz			20 MHz to <100 MHz			
0.226	*0.229*	*0.027*	*0.206*	*0.215*	*0.027*	0 °C to 50 °C
0.084	*0.080*	*0.022*	*0.082*	*0.078*	*0.022*	15 °C to 35 °C
0.046	*0.044*	*0.022*	*0.046*	**0.044**	*0.022*	20 °C to 25 °C
0.226	*0.027*	*0.229*	*0.205*	*0.027*	*0.215*	0 °C to 50 °C
0.083	*0.022*	*0.080*	*0.081*	*0.022*	*0.078*	15 °C to 35 °C
0.045	*0.022*	*0.044*	**0.044**	**0.022**	**0.044**	20 °C to 25 °C
0.023	*0.226*	*0.226*	*0.023*	*0.205*	*0.206*	0 °C to 50 °C
0.022	*0.083*	*0.084*	*0.022*	*0.081*	*0.082*	15 °C to 35 °C
0.022	*0.045*	*0.046*	*0.022*	**0.044**	*0.046*	20 °C to 25 °C
–40 –19 /–13	±0 /+8	+23	–40 –19 /–13	+1 /+7	+23	
Power level in dBm			Power level in dBm			

100 MHz to 4 GHz			>4 GHz to 8 GHz			
0.209	*0.218*	*0.031*	*0.215*	*0.233*	*0.049*	0 °C to 50 °C
0.088	*0.085*	*0.032*	*0.097*	*0.093*	*0.044*	15 °C to 35 °C
0.055	*0.047*	*0.038*	*0.066*	*0.059*	*0.043*	20 °C to 25 °C
0.206	*0.028*	*0.218*	*0.210*	*0.030*	*0.218*	0 °C to 50 °C
0.083	*0.022*	*0.085*	*0.088*	*0.022*	*0.085*	15 °C to 35 °C
0.048	*0.022*	*0.047*	*0.054*	*0.022*	*0.047*	20 °C to 25 °C
0.023	*0.206*	*0.209*	*0.024*	*0.210*	*0.215*	0 °C to 50 °C
0.022	*0.083*	*0.088*	*0.022*	*0.088*	*0.097*	15 °C to 35 °C
0.022	*0.048*	*0.055*	*0.022*	*0.054*	*0.066*	20 °C to 25 °C
–40 –19 /–13	+1 /+7	+23	–40 –19 /–13	+1 /+7	+23	
Power level in dBm			Power level in dBm			

>8 GHz to 12.4 GHz			>12.4 GHz to 18 GHz			
0.224	*0.231*	*0.064*	*0.244*	*0.245*	*0.086*	0 °C to 50 °C
0.111	*0.106*	*0.061*	*0.135*	*0.128*	*0.084*	15 °C to 35 °C
0.084	*0.077*	*0.060*	*0.110*	*0.102*	*0.083*	20 °C to 25 °C
0.216	*0.034*	*0.231*	*0.230*	*0.040*	*0.245*	0 °C to 50 °C
0.096	*0.027*	*0.106*	*0.112*	*0.034*	*0.128*	15 °C to 35 °C
0.063	*0.025*	*0.077*	*0.079*	*0.033*	*0.102*	20 °C to 25 °C
0.024	*0.216*	*0.224*	*0.024*	*0.230*	*0.244*	0 °C to 50 °C
0.022	*0.096*	*0.111*	*0.022*	*0.112*	*0.135*	15 °C to 35 °C
0.022	*0.063*	*0.084*	*0.022*	*0.079*	*0.110*	20 °C to 25 °C
–40 –19 /–13	+1 /+7	+23	–40 –19 /–13	+1 /+7	+23	
Power level in dBm			Power level in dBm			

Accessories for sensors

R&S NRP-Z2

Extension cable	for connecting the sensor to the basic unit or a USB adapter
Length	
Model .05	3.5 m
Model .10	8.5 m (not in conjunction with R&S NRP-Z4)
Total length incl. sensor cable	5 m (model .05) or 10 m (model .10)

R&S NRP-Z3

Active USB adapter with trigger input and plug-in power supply	for connecting a sensor to the USB interface of a PC
Trigger input	
Maximum voltage	±15 V
Logic level	
Low	<0.8 V
High	>2.0 V
Input impedance	approx. 5 kΩ
Plug-in power supply	
Voltage/frequency	100 V to 240 V, 50 Hz to 60 Hz
Tolerance	±10% for voltage, ±3 Hz for frequency
Current consumption	25 mA typ. with sensor connected
Connection	via adapter to all common AC supplies (Europe, UK, USA, Australia)
Connecting cable to PC	
USB interface	type A
Length	approx. 2 m
Dimensions (W x H x L)	
USB adapter	48 mm x 45 mm x 140 mm
Plug-in power supply	52 mm x 73 mm x 110 mm length of line to adapter: 2 m
Weight	
USB adapter	<0.2 kg
Plug-in power supply	<0.3 kg

R&S NRP-Z4

Passive USB adapter (cable)	for connecting a sensor to the USB interface of a PC
USB interface	type A
Length	approx. 2 m

R&S NRP basic unit

Application	multichannel power meter
Sensors	R&S NRP-Z series
Measurement channels	
Basic version	1
Basic version + R&S NRP-B2	2
Basic version + R&S NRP-B2 + R&S NRP-B5	4
Measurement functionality	
Single-channel	see sensor specifications[6], plus: relative measurement referenced to result or user-selectable reference value, storage of minima and maxima (Max, Min, Max-Min), limit monitoring
Display	
Absolute	in W, dBm and dBµV
Relative	in dB, as change in percent (Δ%) or as quotient
Multichannel	simultaneous measurement in up to 4 channels; ratio, relative ratio[34] or difference of results of 2 channels can be displayed (for all functions except Scope)
Display	
Difference	in W
Ratio	in dB, as change in percent (Δ%), as quotient or as one of the following matching parameters: SWR, return loss, reflection coefficient
Relative ratio	in dB, as change in percent (Δ%) or as quotient
Display	
Type	LC graphics screen ¼ VGA (320 x 240) pixel, monochrome, transflective
Backlighting	brightness adjustable
Measurement results	up to 4 results with additional information (Min, Max, Max-Min, frequency) can simultaneously be displayed in separate windows
Representation	digital, digital and analog
Resolution	
Digital values	selectable in 4 steps: 0.001 dB/0.01%/4½ digits (W, quotient) 0.01 dB/0.1%/3½ digits (W, quotient) 0.1 dB/1.0%/2½ digits (W, quotient) 1 dB/1.0%/2½ digits (W, quotient)
Analog display	depending on user-definable scale end values
Manual operation	Windows-oriented menus with hotkeys for the most important functions
Remote control	
Systems	IEC 60625.1 (IEEE488.1) and IEC 60625.2 (IEEE488.2)
Command set	SCPI-1999.0
IEC/IEEE bus	
Interface functions	SH1, AH1, L3, LE3, T5, TE5, SR1, PP1, PP2, RL1, DC1, E2, DT1, C0
Connector	24-pin Amphenol (female)
Firmware download	with a Windows-compatible program from the R&S NRP toolkit via the rear-panel USB interface (type B)

Inputs/outputs (rear panel)

OUT1	
Modes	Analog, Pass/Fail, Off
Analog	recorder output; user-definable linear relation to measurement result (display windows 1 to 4)
Pass/Fail	limit indicator with two user-selectable voltages for identifying the Pass and Fail states in the case of limit monitoring
Off	0 V
Voltage range	0 V to +3.3 V
Setting accuracy	±1% of voltage reading + (0/+8 mV)
Resolution	12 bit (monotone)
Output impedance	1 kΩ
Connector	BNC (female)
IN/OUT 2	
Modes	Analog Out and Trigger In
Analog Out	recorder output; user-definable linear relation to measurement result (display windows 1 to 4)
Electrical characteristics	see OUT1
Trigger In	input for trigger signal to sensors
Maximum voltage	–7 V/+10 V
Logic level	
Low	<0.8 V
High	>2.0 V
Impedance	10 kΩ//100 pF
Connector	BNC (female)

Power supply	
Voltage, frequency	220 V to 240 V, 50 Hz to 60 Hz 100 V to 120 V, 50 Hz to 400 Hz
Tolerance	±10% for voltage and frequency
Apparent power	<80 VA
Dimensions (W x H x D)	274 mm x 112 mm x 267 mm
Weight	<3.0 kg

Options for R&S NRP

R&S NRP-B1

Power reference	
Power	1.00 mW
Uncertainty	
20 °C to 25 °C	*0.85%*
0 °C to 50 °C	*1.00%*
Frequency	50 MHz
SWR	<1.05 typ
RF connector	N (female)

R&S NRP-B2

Second test input (B)	for R&S NRP-Z sensors (available as standard on front panel)

R&S NRP-B5

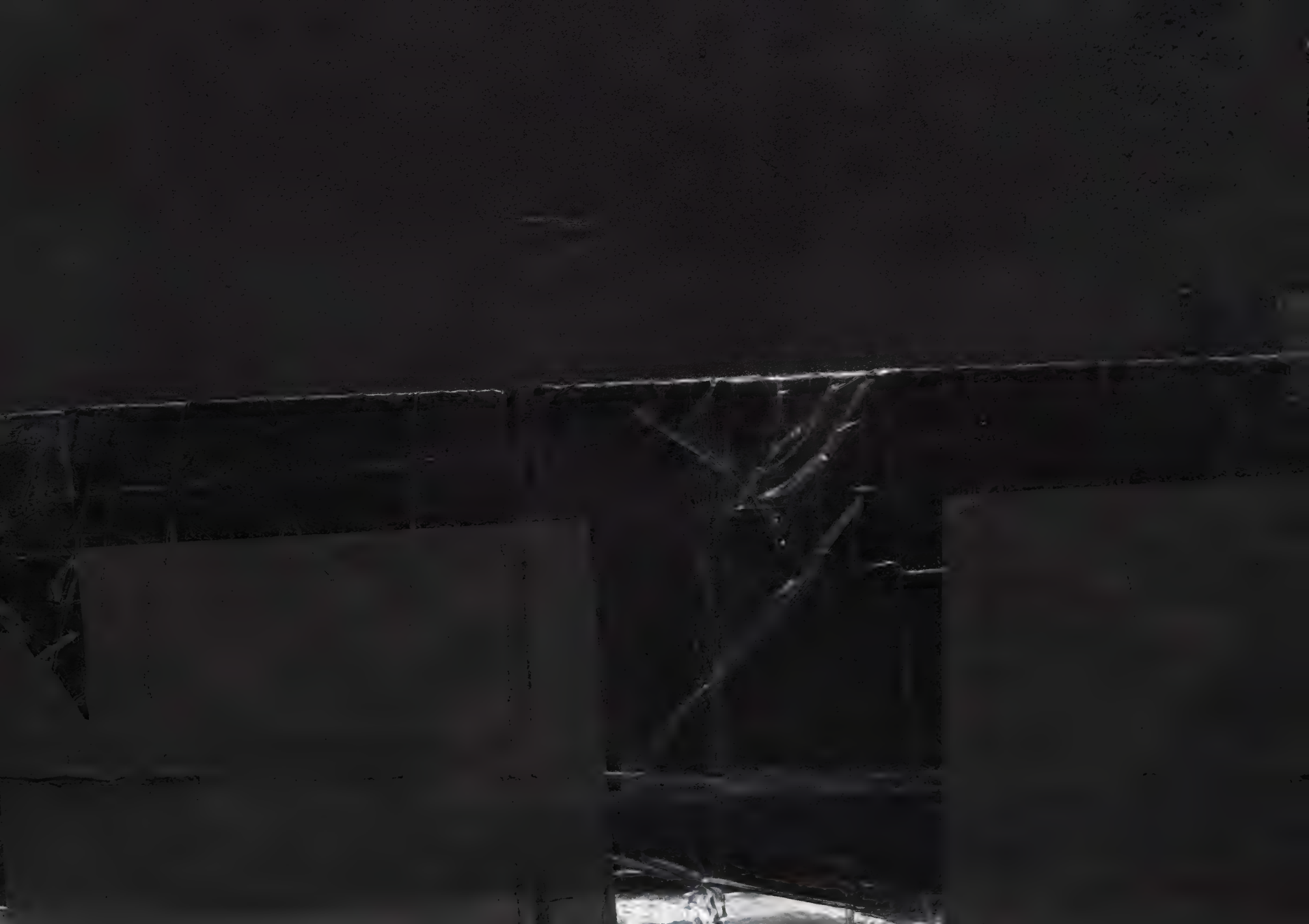
Third (C) and fourth (D) test inputs	for R&S NRP-Z sensors (only on rear panel)

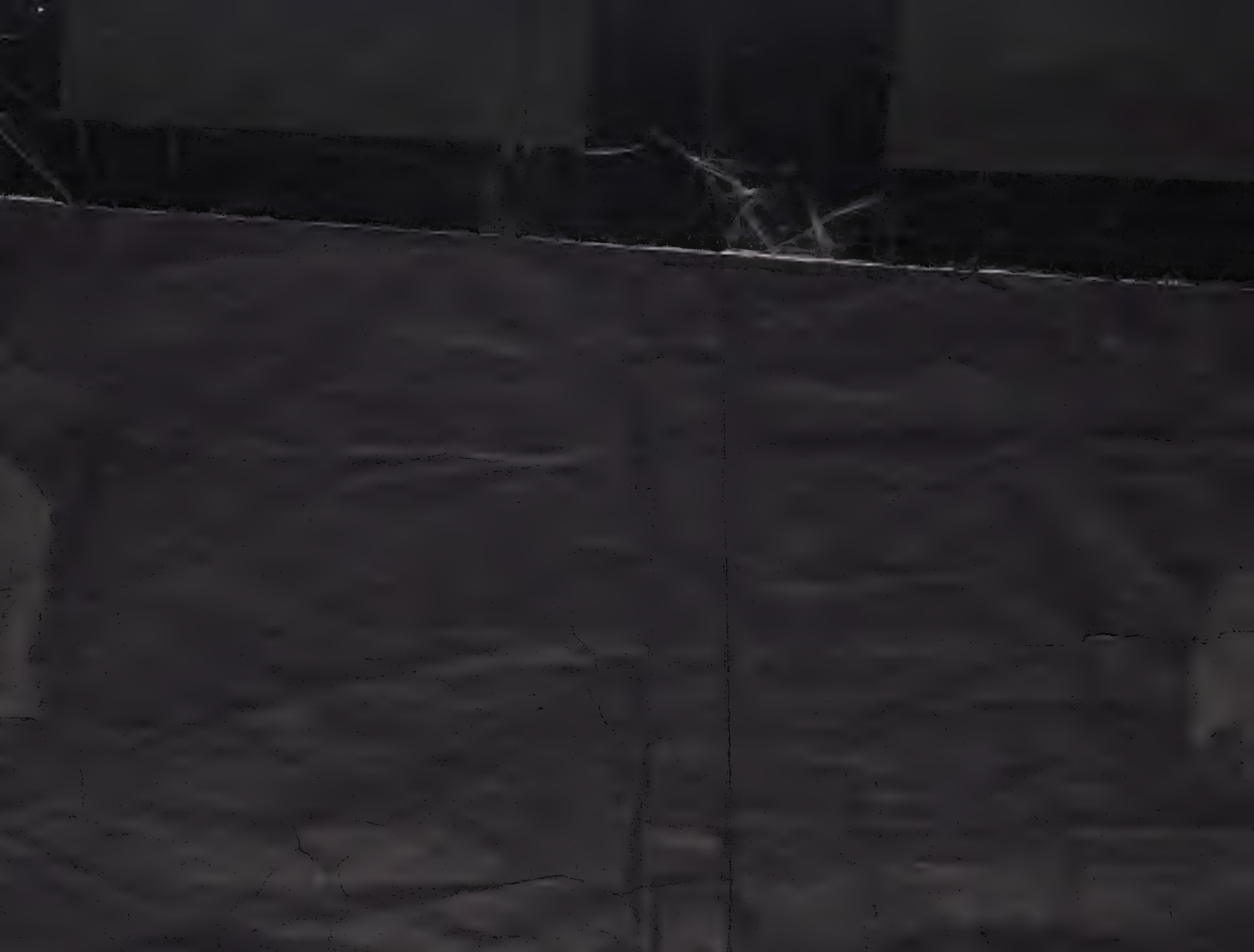
R&S NRP-B6

Rear-panel assembly	for test inputs A and B (only possible if the R&S NRP-B5 option is not installed)

General specifications

Temperature loading[35]	
Operating range and permissible range (in [ ] if different)	meet IEC 60068
R&S NRP with options	0 °C [–5 °C] to +50 °C
R&S NRP-Z2, -Z11, -Z21	0 °C [–10 °C] to +50 °C [+55 °C]
R&S NRP-Z3	0 °C to +40 °C
Storage range	
R&S NRP with options	–20 °C to +70 °C
R&S NRP-Z2, -Z3, -Z11, -Z21	–40 °C to +70 °C
Climatic resistance	meets IEC 60068
Damp heat	+25 °C/+40 °C cyclic at 95% relative humidity
R&S NRP-Z3, -Z11, -Z21	with restrictions: non-condensing
Mechanical resistance	
Vibration, sinusoidal	meets IEC 60068 5 Hz to 55 Hz, max. 2 g 55 Hz to 150 Hz, 0.5 g constant
Vibration, random	meets IEC 60068 10 Hz to 500 Hz, 1.9 g (rms)
Shock	meets IEC 60068; 40 g shock spectrum
Air pressure	
Operation	795 hPa (2000 m) to 1060 hPa
Transport	566 hPa (4500 m) to 1060 hPa
Electromagnetic compatibility	meets EN 61326, EN 55011
Safety	meets EN 61010-1





Γ correction activated.
Referenced to 0 dBm.

[15] Specifications apply to timeslots with a duration of 12.5% referenced to the signal period (duty cycle 1:8). For other waveforms the following equation applies:
lower measurement limit = 200 pW x $\sqrt{\text{measurement time/integration time}}$
For measurement time, see specifications. For integration time, see footnote [16].

[16] With a resolution of 256 points.

[17] Transition regions can be shifted by up to –20 dB if automatic path selection has been chosen.

[18] The Scope function will be available for the R&S NRP basic unit as of spring 2003.

[19] Portion of signal that is the subject of measurement (sampling). The factor of 2 is due to the measurement being performed in two equal periods of time (chopper amplifier) separated by 100 µs. If averaging is activated, the averaging factor determines the number of measurement windows to be averaged.

[20] For calculating the pulse power of periodic bursts from an average power measurement.

[21] To increase measurement speed, the power sensor can be operated in buffered mode. In this mode, measurement results are stored in a buffer of user-definable size and then output as a block of data when the buffer is full. To enhance measurement speed even further, the sensor can be set to record the entire series of measurements when triggered by a single event. In this case the power sensor automatically starts a new measurement as soon as it completes the preceding one.
This parameter enables power measurements on modulated bursts. The parameter must be longer in duration than modulation-induced power drops within the burst, but at least 10 µs shorter than the gap between the end of one burst and the beginning of the next one.

[22] To exclude unwanted portions at the beginning or end of the measurement window from the measurement result

[23] Portion of signal that is the subject of measurement (sampling). Periodic signals are measured in two equal periods of time (chopper amplifier) separated by 100 µs. If averaging is activated, the averaging factor determines the number of measurement windows to be averaged.

[24] To prevent aliasing in the case of signals with discrete modulation frequencies between 100 kHz and 1 MHz.

[25] Two standard deviations, 10.24 s integration time (see footnote [16]). Multiplying noise specifications by $\sqrt{10.24}$ s/integration time yields the noise contribution at other integration times. Smoothing (see under Measurement window) increases noise by 22%

[26] Two standard deviations, for power levels greater than 500 nW (–33 dBm) in Continuous Average mode with automatic path selection (User def'd crossover deactivated or set to 0 dB). Within a measurement subrange, relative measurement uncertainty due to noise is inversely proportional to the measured power. The specified values refer to 500 nW (–33 dBm) and the lower limits of paths 2 and 3 at 50 µW (–13 dBm) and 5 mW (+7 dBm) respectively

[27] Integration time is defined as the total time used for sampling the signal. It can be calculated by multiplying the duration of the measurement window by the averaging factor.

[28] Expanded uncertainty (k = 2) after zeroing (for 4 s). Zeroing for more than 4 s lowers uncertainty correspondingly (half values for 16 s)

[29] Within 1 hour after zeroing, permissible temperature change ±1 °C, following 2-hour warm-up of power sensor.

[30] Magnitude of measurement error with reference to an ideal thermal power sensor that measures the sum power of carrier and harmonics. Specified values apply to automatic path selection (User def'd crossover deactivated or set to 0 dB) and power levels up to +20 dBm. Above +20 dBm, specified values must be multiplied by a factor of 1.25 per 1 dB rise in power level. Within a measurement subrange, errors (uncertainties) are proportional to the measured power in W. The specified values refer to 10 µW (–20 dBm) for path 1, 1 mW (0 dBm) for path 2 and 100 mW (20 dBm) for path 3.

[31] Adhering to specified error limits implies that harmonics above 25 GHz (R&S NRP-Z11) and 56 GHz (R&S NRP-Z21) are at least 20 dB lower than required at other frequencies

[32] Measurement error with reference to CW signal of equal power and frequency. Specified values apply to automatic path selection (User def'd crossover deactivated or set to specified value) and power levels up to (+20 dBm + User def'd crossover). Above this level, specified values must be multiplied by a factor of 1.25 per 1 dB rise in power level. In the measurement subranges, the specified values apply to –20 dBm for path 1, 0 dBm for path 2 and +20 dBm for path 3

[33] The AUTO mode is not available in conjunction with the R&S NRP basic unit.

[34] Characteristics like for a conventional power meter. The averaging factor increases continuously as power decreases, but not to the extent that would be necessary to keep the relative noise content at the same level.

[35] Limits the averaging factor when measuring very low powers or when the noise content is set to a very small value (status information available).

[36] Reference timeslot and reference point are user-definable.

[37] Preferably used with determined modulation, when the duration of the measurement window cannot be matched to the modulation period. Compared to a rectangular window, display noise is about 22% higher.

[38] Valid for Repeat mode, extending from the beginning to the conclusion of all transfers via the USB interface of the power sensor. Measurement times under remote control of the R&S NRP basic unit via IEC/IEEE bus are approximately 2.5 ms longer, extending from the start of the measurement until the measurement result is supplied to the output buffer of the R&S NRP

[39] For calculation of measurement time, N must be set to twice the averaging factor if the expression (number of timeslots x nominal width + 100 µs + trigger delay) exceeds the trigger period.

[40] This function can be used to counteract interactions between the signal source and the input of the power sensor (input of a component ahead of the power sensor if s-parameter correction is activated). By using this function, the nominal power of the source into 50 Ω can be measured (without this correction: power of the incident wave).

[41] Expanded uncertainty (k = 2) for absolute power measurements on CW signals at calibration levels (–20 dBm for path 1, 0 dBm for paths 2 and 3) and the calibration frequencies (10 MHz, 15 MHz, 20 MHz, 30 MHz, 50 MHz, 100 MHz; from 250 MHz to 8 (18) GHz in increments of 250 MHz). Specifications include zero offset and display noise (up to a 2 σ value of 0.004 dB).

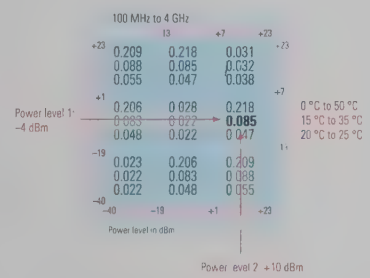
[42] Expanded uncertainty (k = 2) for absolute power measurements on CW signals with automatic path selection. Specifications include display noise with a 2 σ value up to 0.01 dB and zero offset for levels from –40 dBm to +23 dBm. Higher display noise and the effect of zero offset at lower levels must be considered separately.
Example: Power to be measured is 3.2 nW (–55 dBm) at 1.9 GHz; ambient temperature is 29 °C; automatic path selection is set. Typical absolute uncertainty due to zero offset equals 64 pW, corresponding to a relative measurement uncertainty of .

$$10 \times \lg\left(\frac{3.2\ \text{nW} + 64\ \text{pW}}{3.2\ \text{nW}}\right) \quad 0.086\ \text{dB}$$

Combined with the specified value of 0.081 dB for the uncertainty of absolute power measurements, the total uncertainty is $\sqrt{0.086^2+0.081^2}$ dB = 0.12 dB. Noise content exceeding 0.01 dB should be considered in the same way.

[43] Expanded uncertainty (k = 2) for relative power measurements on CW signals with automatic path selection. Specifications include display noise with a 2 σ value up to 0.01 dB for both the measurement and the reference level as well as zero offsets for all levels from –40 dBm to +23 dBm. Below –40 dBm, the effect of increased relative zero offset must be taken into account (only for the lower level, if both levels are below –40 dBm). Display noise exceeding 0.01 dB must be considered separately for both the measurement level and the reference level (if applicable). See example in footnote [31] for calculation of total uncertainty.

[44] Reading the measurement uncertainty for relative power measurements
The example shows a level step of approx. 14 dB (–4 dBm → +10 dBm) at 1.9 GHz and an ambient temperature of 28 °C



[45] Quotient of a measured and a stored reference power ratio, e.g. for measuring gain compression of amplifiers

[46] The operating temperature range defines the span of ambient temperature in which the instrument complies with specifications. In the permissible temperature range, the instrument is still functioning but adherence to specifications is not warranted

Ordering information

Description	Type	Order No.
Basic Unit		
Power Meter	R&S NRP	1143.8500.02
Power Sensors		
200 pW to 200 mW, 10 MHz to 8 GHz	R&S NRP-Z11	1138.3004.02
200 pW to 200 mW, 10 MHz to 18 GHz	R&S NRP-Z21	1137.6000.02
Options		
Sensor Check Source	R&S NRP-B1	1146.9008.02
Second Sensor Input (B)	R&S NRP-B2	1146.8801.02
3rd and 4th Sensor Inputs (C, D)[1]	R&S NRP-B5	1146.9608.02
Rear-Panel Sensor Inputs A and B[2]	R&S NRP-B6	1146.9908.02
Battery Supply	R&S NRP-B3	1146.8501.02
Recommended extras		
Sensor Extension Cable to 5 m	R&S NRP-Z2	1146.6750.05
Sensor Extension Cable to 10 m	R&S NRP-Z2	1146.6750.10
USB Adapter (active)	R&S NRP-Z3	1146.7005.02
USB Adapter (passive)	R&S NRP-Z4	1146.8001.02
19" Rack Adapter (R&S NRP + dummy)	R&S ZZA-T26	1109.4387.00
19" Rack Adapter (two R&S NRPs)	R&S ZZA-T27	1109.4393.00

[1] Option R&S NRP-B2 required.
[2] Not in conjunction with the R&S NRP-B5.

Certified Environmental System ISO 14001 REG. NO 1954

Certified Quality System ISO 9001 DQS REG. NO 1954

ROHDE&SCHWARZ

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Before putting the product into operation for the first time, make sure to read the following

Safety Instructions

Rohde & Schwarz makes every effort to keep the safety standard of its products up to date and to offer its customers the highest possible degree of safety. Our products and the auxiliary equipment required for them are designed and tested in accordance with the relevant safety standards. Compliance with these standards is continuously monitored by our quality assurance system. This product has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, Rohde & Schwarz will be happy to answer them.

Furthermore, it is your responsibility to use the product in an appropriate manner. This product is designed for use solely in industrial and laboratory environments or in the field and must not be used in any way that may cause personal injury or property damage. You are responsible if the product is used for an intention other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall assume no responsibility for such use of the product.

The product is used for its designated purpose if it is used in accordance with its operating manual and within its performance limits (see data sheet, documentation, the following safety instructions). Using the products requires technical skills and knowledge of English. It is therefore essential that the products be used exclusively by skilled and specialized staff or thoroughly trained personnel with the required skills. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation.

Symbols and safety labels

Observe operating instructions	Weight indication for units >18 kg	Danger of electric shock	Warning! Hot surface	PE terminal	Ground	Ground terminal	Attention! Electrostatic sensitive devices

Supply voltage ON/OFF	Standby indication	Direct current (DC)	Alternating current (AC)	Direct/alternating current (DC/AC)	Device fully protected by double/reinforced insulation

Observing the safety instructions will help prevent personal injury or damage of any kind caused by dangerous situations. Therefore, carefully read through and adhere to the following safety instructions before putting the product into operation. It is also absolutely essential to observe the additional safety instructions on personal safety that appear in other parts of the documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by Rohde & Schwarz, including instruments, systems and all accessories.

Tags and their meaning

DANGER	This tag indicates a safety hazard with a high potential of risk for the user that can result in death or serious injuries.
WARNING	This tag indicates a safety hazard with a medium potential of risk for the user that can result in death or serious injuries.
CAUTION	This tag indicates a safety hazard with a low potential of risk for the user that can result in slight or minor injuries.
ATTENTION	This tag indicates the possibility of incorrect use that can cause damage to the product.
NOTE	This tag indicates a situation where the user should pay special attention to operating the product but which does not lead to damage.

Basic safety instructions

1. The product may be operated only under the operating conditions and in the positions specified by the manufacturer. Its ventilation must not be obstructed during operation. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products:
   IP protection 2X, pollution severity 2, overvoltage category 2, use only in enclosed spaces, max. operation altitude max. 2000 m.
2. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed. The product may be opened only by authorized, specially trained personnel. Prior to performing any work on the product or opening the product, the instrument must be disconnected from the supply network. Any adjustments, replacements of parts, maintenance or repair must be carried out only by technical personnel authorized by Rohde & Schwarz. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, PE conductor test, insulation resistance measurement, leakage current measurement, functional test).
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens) such as aluminum cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties), consult a physician immediately to determine the cause.
4. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn life requires increased protection, pregnant women should be protected by appropriate measures. Persons with pacemakers may also be endangered by electromagnetic radiation. The employer is required to assess workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the danger.

5. Operating the products requires special training and intense concentration. Disabled persons should not use the products unless it is made certain that their disability has no adverse effects while they are operating the products.
6. Prior to switching on the product, it must be ensured that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
7. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with earthing contact and protective earth connection.
8. Intentionally breaking the protective earth connection either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
9. If the product has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases, it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply. If products without power switches are integrated in racks or systems, a disconnecting device must be provided at the system level.
10. Never use the product if the power cable is damaged. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by e.g. tripping over the cable or suffering an electric shock.
11. The product may be operated only from TN/TT supply networks fused with max. 16 A.
12. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise this can result in sparks, fire and/or injuries.
13. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
14. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
15. Ensure that the connections with information technology equipment comply with IEC950/EN60950.
16. Never remove the cover or part of the housing while you are operating the product. This will expose circuits and components and can lead to injuries, fire or damage to the product.
17. If a product is to be permanently installed, the connection between the PE terminal on site and the product's PE conductor must be made first before any other connection is made. The product may be installed and connected only by a skilled electrician.
18. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that suitable protection is provided for users and products.
19. Do not insert any objects into the openings in the housing that are not designed for this purpose. Never pour any liquids onto or into the housing. This can cause short circuits inside the product and/or electric shocks, fire or injuries.
20. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a thunderstorm) can reach the product. Otherwise the operating personnel will be endangered by electric shocks.

21. Rohde & Schwarz products are not protected against penetration of water, unless otherwise specified (see also safety instruction 1.). If this is not taken into account, there exists the danger of electric shock or damage to the product, which can also lead to personal injury.
22. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product was moved from a cold to a warm environment.
23. Do not close any slots or openings on the product, since they are necessary for ventilation and prevent the product from overheating. Do not place the product on soft surfaces such as sofas or rugs or inside a closed housing, unless this is well ventilated.
24. Do not place the product on heat-generating devices such as radiators or fan heaters. The temperature of the environment must not exceed the maximum temperature specified in the data sheet.
25. Batteries and storage batteries must not be exposed to high temperatures or fire. Keep batteries and storage batteries away from children. If batteries or storage batteries are improperly replaced, this can cause an explosion (warning: lithium cells). Replace the battery or storage battery only with the matching Rohde & Schwarz type (see spare parts list). Batteries and storage batteries are hazardous waste. Dispose of them only in specially marked containers. Observe local regulations regarding waste disposal. Do not short-circuit batteries or storage batteries.
26. Please be aware that in the event of a fire, toxic gases that may be hazardous to your health may escape from the product.
27. Please be aware of the weight of the product. Be careful when moving it; otherwise you may injure your back or other parts of your body.
28. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves).
29. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. The driver is always responsible for the safety of the vehicle; the manufacturer assumes no responsibility for accidents or collisions.
30. If a laser product (e.g. a CD/DVD drive) is integrated in a Rohde & Schwarz product, do not use any other settings or functions than those described in the documentation. Otherwise this may be hazardous to your health, since the laser beam can cause irreversible damage to your eyes. Never try to take such products apart, and never look into the laser beam.

Por favor lea imprescindiblemente antes de la primera puesta en funcionamiento las siguientes informaciones de seguridad

Informaciones de seguridad

Es el principio de Rohde&Schwarz de tener a sus productos siempre al día con los estandards de seguridad y de ofrecer a sus clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestra sección de gestión de la seguridad de calidad controla constantemente que sean cumplidas estas normas. Este producto ha sido fabricado y examinado según el comprobante de conformidad adjunto según las normas de la CE y ha salido de nuestra planta en estado impecable según los estandards técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, deberá el usuario atenerse a todas las informaciones, informaciones de seguridad y notas de alerta. Rohde&Schwarz está siempre a su disposición en caso de que tengan preguntas referentes a estas informaciones de seguridad.

Además queda en la responsabilidad del usuario utilizar el producto en la forma debida. Este producto solamente fue elaborado para ser utilizado en la indústria y el laboratorio o para fines de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda ser dañada. El uso del producto fuera de sus fines definidos o despreciando las informaciones de seguridad del fabricante queda en la responsabilidad del usuario. El fabricante no se hace en ninguna forma responsable de consecuencias a causa del maluso del producto.

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado dentro de las instrucciones del correspondiente manual del uso y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso de los productos hace necesarios conocimientos profundos y el conocimeinto del idioma inglés. Por eso se deberá tener en cuenta de exclusivamente autorizar para el uso de los productos a personas péritas o debidamente minuciosamente instruidas con los conocimientos citados. Si fuera necesaria indumentaria de seguridad para el uso de productos de R&S, encontrará la información debida en la documentación del producto en el capítulo correspondiente.

Símbolos y definiciones de seguridad

Ver manual de instrucciones del uso	Informaciones para maquinaria con uns peso de > 18kg	Peligro de golpe de corriente	¡Cuidado! Superficie caliente	Conexión a conductor protector	Conexión a tierra	Conexión a masa conductora	¡Cuidado! Elementos de construción con peligro de carga electroestática

potencia EN MARCHA/PARADA	Indicación Stand-by	Corriente continua DC	Corriente alterna AC	Corriente continua/alterna DC/AC	El aparato está protegido en su totalidad por un aislamiento de doble refuerzo

Tener en cuenta las informaciones de seguridad sirve para tratar de evitar daños y peligros de toda clase. Es necesario de que se lean las siguientes informaciones de seguridad concienzudamente y se tengan en cuenta debidamente antes de la puesta en funcionamiento del producto. También deberán ser tenidas en cuenta las informaciones para la protección de personas que encontrarán en otro capítulo de esta documentación y que también son obligatorias de seguir. En las informaciones de seguridad actuales hemos juntado todos los objetos vendidos por Rohde&Schwarz bajo la denominación de „producto", entre ellos también aparatos, instalaciones así como toda clase de accesorios.

Palabras de señal y su significado

PELIGRO	Indica un punto de peligro con gran potencial de riesgo para el ususario.Punto de peligro que puede llevar hasta la muerte o graves heridas.
ADVERTENCIA	Indica un punto de peligro con un protencial de riesgo mediano para el usuario. Punto de peligro que puede llevar hasta la muerte o graves heridas .
CUIDADO	Indica un punto de peligro con un protencial de riesgo pequeño para el usuario. Punto de peligro que puede llevar hasta heridas leves o pequeñas
ATENCIÓN	Indica la posibilidad de utilizar mal el producto y a consecuencia dañarlo.
INFORMACIÓN	Indica una situación en la que deberían seguirse las instrucciones en el uso del producto, pero que no consecuentemente deben de llevar a un daño del mismo.

Informaciones de seguridad elementales

1. El producto solamente debe ser utilizado según lo indicado por el fabricante referente a la situación y posición de funcionamiento sin que se obstruya la ventilación. Si no se convino de otra manera, es para los productos R&S válido lo que sigue:
modo de protección IP 2X, grado de suciedad 2, categoría de sobrecarga eléctrica 2, utilizar solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar.
2. En todos los trabajos deberán ser tenidas en cuenta las normas locales de seguridad de trabajo y de prevención de accidentes. El producto solamente debe de ser abierto por personal périto autorizado. Antes de efectuar trabajos en el producto o abrirlo deberá este ser desconectado de la corriente. El ajuste, el cambio de partes, la manutención y la reparación deberán ser solamente efectuadas por electricistas autorizados por R&S.Si se reponen partes con importancia para los aspectos de seguridad (por ejemplo el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales.Despues de cada recambio de partes elementales para la seguridad deberá ser efectuado un control de seguridad (control a primera vista, control de conductor protector, medición de resistencia de aislamiento, medición de medición de la corriente conductora, control de funcionamiento).
3. Como en todo producto de fabricación industrial no puede ser excluido en general de que se produzcan al usarlo elementos que puedan generar alergias, los llamados elementos alergénicos (por ejemplo el aluminio). Si se producieran en el trato con productos R&S reacciones alérgicas, como por ejemplo urticaria, estornudos frecuentes, irritación de la conjuntiva o dificultades al respirar, se deberá consultar inmediatamente a un médico para averigurar los motivos de estas reacciones.

4. Ciertos productos, como por ejemplo las instalaciones de radiación HF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. En vista a la protección de la vida en desarrollo deberían ser protegidas personas embarazadas debidamente. También las personas con un bypass pueden correr peligro a causa de la radiación electromagnética. El empresario está comprometido a valorar y señalar areas de trabajo en las que se corra un riesgo de exposición a radiaciones aumentadas de riesgo aumentado para evitar riesgos.
5. La utilización de los productos requiere instrucciones especiales y una alta concentracion en el manejo. Personas minusválidas solamente deberán utilizar estos productos si está por seguro de que a causa de su handicap no podrá surgir ninguna restricción en el manejo del producto.
6. Antes de la puesta en marcha del producto se deberá tener por seguro de que la tensión preseleccionada en el producto equivalga a la del la red de distribución. Si es necesario cambiar la preselección de la tensión también se deberán en caso dabo cambiar los fusibles correspondientes del prodcuto.
7. Productos de la clase de seguridad I con alimentación móvil y enchufe individual de producto solamente deberán ser conectados para el funcionamiento a tomas de corriente de contacto de seguridad y con conductor protector conectado.
8. Queda prohibida toda clase de interrupción intencionada del conductor protector, tanto en la toma de corriente como en el mismo producto ya que puede tener como consecuencia el peligro de golpe de corriente por el producto. Si se utilizaran cables o enchufes de extensión se deberá poner al seguro, que es controlado su estado técnico de seguridad.
9. Si el producto no está equipado con un interruptor para desconectarlo de la red, se deberá considerar el enchufe del cable de distribución como interruptor. En estos casos deberá asegurar de que el enchufe sea de fácil acceso y nabejo (medida del cable de distribución aproximadamente 2 m). Los interruptores de función o electrónicos no son aptos para la el corte de la red eléctrica. Si los productos sin interruptor están integrados en construciones o instalaciones, se deberá instalar el interruptor al nivel de la instalación.
10. No utilice nunca el producto si está dañado el cable eléctrico. Asegure a través de las medidas de protección y de instalación adecuadas de que el cable de eléctrico no pueda ser dañado o de que nadie pueda ser dañado por él, por ejemplo al tropezar o por un golpe de corriente.
11. Solamente está permitido el funcionamiento en redes de distribución TN/TT aseguradas con fusibles de como máximo 16 A.
12. Nunca conecte el enchufe en tomas de corriente sucias o llenas de polvo. Introduzca el enchufe por completo y fuertemente en la toma de corriente. Si no tiene en consideración estas indicaciones se arriesga a que se originen chispas, fuego y/o heridas.
13. No sobrecargue las tomas de corriente, los cables de extensión o los enchufes de extensión ya que esto pudiera causar fuego o golpes de corriente.
14. En las mediciones en circuitos de corriente con una tensión de entrada de Ueff > 30 V se deberá tomar las precauciones debidas para impedir cualquier peligro (por ejemplo medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
15. En caso de conexión con aparatos de la técnica informática se deberá tener en cuenta que estos cumplan los requisitos de la EC950/EN60950.
16. Nunca abra la tapa o parte de ella si el producto está en funcionamiento. Esto pone a descubierto los cables y componentes eléctricos y puede causar heridas, fuego o daños en el producto.
17. Si un producto es instalado fijamente en un lugar, se deberá primero conectar el conductor protector fijo con el conductor protector del aparato antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efecutadas por un electricista especializado.

18. En caso de que los productos que son instalados fijamente en un lugar sean sin protector implementado, autointerruptor o similares objetos de protección, deberá la toma de corriente estar protegida de manera que los productos o los usuarios estén suficientemente protegidos.
19. Por favor, no introduzca ningún objeto que no esté destinado a ello en los orificios de la caja del aparato. No vierta nunca ninguna clase de líquidos sobre o en la caja. Esto puede producir corto circuitos en el producto y/o puede causar golpes de corriente, fuego heridas.
20. Asegúrese con la protección adecuada de que no pueda originarse en el producto una sobrecarga por ejemplo a causa de una tormenta. Si no se verá el personal que lo utilice expuesto al peligro de un golpe de corriente.
21. Los productos R&S no están protegidos contra el agua si no es que exista otra indicación, ver también punto 1. Si no se tiene en cuenta esto se arriesga el peligro de golpe de corriente o de daños en el producto lo cual también puede llevar al peligro de personas.
22. No utilice el producto bajo condiciones en las que pueda producirse y se hayan producido líquidos de condensación en o dentro del producto como por ejemplo cuando se desplaza el producto de un lugar frío a un lugar caliente.
23. Por favor no cierre ninguna ranura u orificio del producto, ya que estas son necesarias para la ventilación e impiden que el producto se caliente demasiado. No pongan el producto encima de materiales blandos como por ejemplo sofás o alfombras o dentro de una caja cerrada, si esta no está suficientemente ventilada.
24. No ponga el producto sobre aparatos que produzcan calor, como por ejemplo radiadores o calentadores. La temperatura ambiental no debe superar la temperatura máxima especificada en la hoja de datos.
25. Baterías y acumuladores no deben de ser expuestos a temperaturas altas o al fuego. Guardar baterías y acumuladores fuera del alcance de los niños. Si las baterías o los acumuladores no son cambiados con la debida atención existirá peligro de explosión (atención celulas de Litio). Cambiar las baterías o los acumuladores solamente por los del tipo R&S correspondiente (ver lista de piezas de recambio). Baterías y acumuladores son deshechos problemáticos. Por favor tirenlos en los recipientes especiales para este fín. Por favor tengan en cuenta las prescripciones nacionales de cada país referente al tratamiento de deshechos. Nunca sometan a las baterías o acumuladores a un corto circuito.
26. Tengan en consideración de que en caso de un incendio pueden escaparse gases tóxicos del producto, que pueden causar daños a la salud.
27. Por favor tengan en cuenta el peso del producto. Muevanlo cuidadosamente ya que el peso puede causar lesiones de la espalda u otros daños físicos.
28. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptas para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (por ejemplo paredes y estantes).
29. Si llega a utilizar el producto dentro de un vehículo, queda en la responsabilidad absoluta del conductor que conducir el vehículo de manera segura. Asegure el producto dentro del vehículo debidamente para evitar en caso de un accidente las lesiones u otra clase de daños. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Siempre queda en la responsabilidad absoluta del conductor la seguridad del vehículo y el fabricante no asumirá ninguna clase de responsabilidad por accidentes o colisiones.
30. Dado el caso de que esté integrado und producto de laser en un producto R&S (por ejemplo CD/DVD-ROM) no utilice otras instalaciones o funciones que las descritas en la documentación. De otra manera pondrá en peligro su salud, ya que el rayo laser puede dañar irreversiblemente sus ojos. Nunca trate de descomponer estos productos. Nunca mire dentro del rayo laser.

Certified Quality System

DIN EN ISO 9001 : 2000
DIN EN 9100 : 2003
DIN EN ISO 14001 : 1996

DQS REG. NO 001954 QM/ST UM

QUALITÄTSZERTIFIKAT

Sehr geehrter Kunde,
Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Managementsystems entwickelt, gefertigt und geprüft.
Das Rohde & Schwarz Managementsystem ist zertifiziert nach:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:1996

CERTIFICATE OF QUALITY

Dear Customer,
you have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde & Schwarz quality management system is certified according to:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:1996

CERTIFICAT DE QUALITÉ

Cher Client,
vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde & Schwarz a été homologué conformément aux normes:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:1996

ROHDE&SCHWARZ

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 2002-36

This is to certify that:

Equipment type	Stock No.	Designation
NRP	1143.8500.02	Power Meter
NRP-B1	1146.9008.02	Sensor Check Source
NRP-B2	1146.8801.02	Second Sensor Input
NRP-B5	1146.9608.02	3rd und 4th Sensor
NRP-B6	1146.9908.02	Rear-Panel Sensor
NRP-Z3	1146.7005.02	USB Adapter
NRP-Z4	1146.8001.02	USB Adapter
NRP-Z11	1138.3004.02	Average Power Sensor
NRP-Z21	1137.6000.02	Average Power Sensor

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1993 + A2 : 1995
EN55011 : 1998 + A1 : 1999
EN61326 : 1997 + A1 : 1998 + A2 : 2001

For the assessment of electromagnetic compatibility, the limits of radio interference for Class B equipment as well as the immunity to interference for operation in industry have been used as a basis.

Affixing the EC conformity mark as from 2002

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 2002-06-27

Central Quality Management FS-QZ / Becker

Customer Support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz equipment, contact one of our Customer Support Centers. A team of highly qualified engineers provides telephone support and will work with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz equipment.

Up-to-date information and upgrades

To keep your Rohde & Schwarz equipment always up-to-date,
please subscribe to an electronic newsletter at
http://www.rohde-schwarz.com/www/response.nsf/newsletterpreselection

or request the desired information and upgrades via email from your Customer Support Center (addresses see below).

Feedback

We want to know if we are meeting your support needs. If you have any comments please email us and let us know CustomerSupport.Feedback@rohde-schwarz.com.

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8:00 AM – 8:00 PM Eastern Standard Time (EST)

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1 Putting into Operation

Follow the instructions below precisely to prevent damage to the sensor – particularly when you are putting it into operation for the first time.

Unpacking the sensor

Remove the sensor from its packing and check that nothing is missing. Inspect all items for damage. If you discover any damage, inform the carrier responsible immediately and keep the packing to support any claims for compensation.

It is also best to use the original packing if the sensor is to be shipped or transported at a later date..

The sensor contains components which can be destroyed by electrostatic discharges. To prevent this happening, never touch the inner conductor of the RF connector and never open the sensor.

Connecting the sensor

To prevent EMI, the sensor must never be operated with its enclosure wholly or partially removed. Only use shielded cables that meet the relevant EMC standards.

Never exceed the maximum RF power limit. Even brief overloads can destroy the sensor.

In many cases, the RF connector only requires manual tightening. However, for maximal measurement accuracy, the RF connector must be tightened using a torque wrench with a nominal torque of 1.36 Nm (12" lbs.).

Operation with the R&S NRP basic unit

Connecting the sensor to the R&S NRP basic unit

The sensor can be connected to the R&S NRP basic unit when it is in operation. The interface connector must be inserted, red marking upwards, into one of the R&S NRP basic unit's sensor connectors. When the sensor is connected, it is detected by the R&S NRP basic unit and initialized.

Connecting the sensor to the DUT

The Sensor R&S NRP-Z11/-Z21 has a male N connector and so can be connected to any standard female N connector. Using light pressure, and keeping the male N connector perpendicular, insert it into the female N connector and tighten the N connector locking nut (right-hand thread).

PC control

Hardware and software requirements

The following requirements must be met if the sensor is to be controlled by a PC via an interface adapter:

- The PC must have a USB port.
- The PC's operating system must support the USB port. This is the case with Windows™ 98, Windows™ ME, Windows™ 2000, Windows™ XP and more recent versions of the Windows™ operating system.
- The USB device drivers in the supplied *NRP Toolkit* software package must be installed.

If these requirements are met, the sensor can be controlled using a suitable application program such as the NrpFlashup program contained in the NRP Toolkit (includes the modules Power Viewer, USB Terminal, Firmware Update and Update S-Parameters).

When you insert the CD-ROM supplied with the R&S NRP, the NRP Toolkit is automatically installed on your PC. The rest of the procedure is self-explanatory.

The sensor can be powered in two ways:

- *Self-powered* from a separate power supply via the Active USB Adapter R&S NRP-Z3.
- *Bus-powered* from the PC or a USB hub with its own power supply (*self-powered hub*) via the Active USB Adapter R&S NRP-Z3 or via the Passive USB Adapter R&S NRP-Z4.

As the sensor is a *high-power device*, there is no guarantee that it can be powered from all types of laptop or notebook in the *bus-powered* mode. To be sure, you should determine the current at the USB connectors beforehand:

- *In the Windows™ start menu, select* ***Settings – Control Panel***
- *Select the* ***System*** *icon*
- *Select the* ***Hardware*** *tab*
- *By clicking on the button with that name, start the* ***Device Manager***
- *Open* ***USB Controller*** *(all USB controllers, hubs and USB devices are listed here)*
- *Double-click on* ***USB Root Hub*** *or select* ***Properties*** in the context menu *(use the right-hand mouse button)*
- *Select the* ***Power*** *tab (Fig. 1-1). If the hub is self-powered and the total power available is, as indicated by* ***Hub Information,*** *500 mA per port, high-power devices can be connected.*

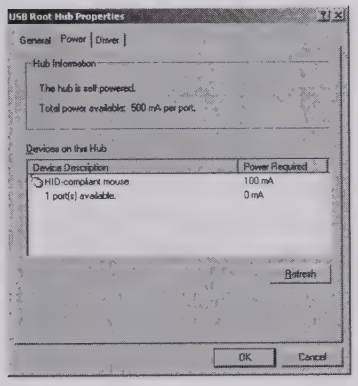

Fig. 1-1 Displaying the total available power of a USB port

If you have any doubts, ask the manufacturer if the USB port on your laptop or notebook can handle *high-power devices.*

Operation via the Active USB Adapter R&S NRP-Z3

Figure 1-2 shows the configuration with the Active USB Adapter R&S NRP-Z3, which also makes it possible to feed in a trigger signal for the *Timeslot* and *Scope* modes. The order in which the cables are connected is not critical.

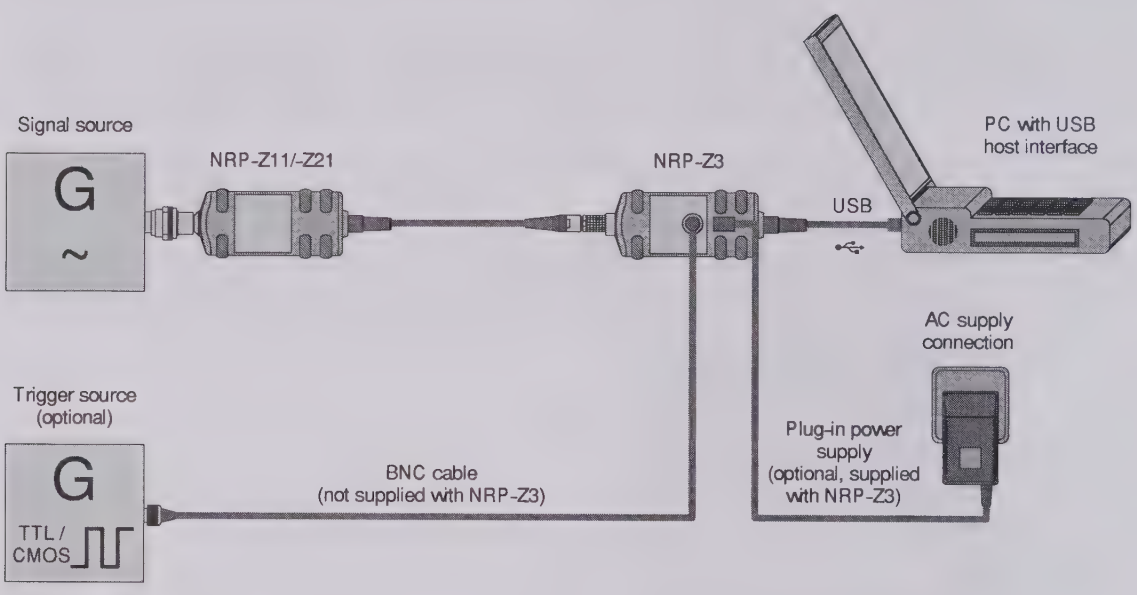

Fig. 1-2 Configuration with Active USB Adapter R&S NRP-Z3

The plug-in power supply for the R&S NRP-Z3 can be powered from a single-phase AC source with a nominal voltage range of 100 V to 240 V and a nominal frequency between 50 Hz and 60 Hz. The plug-in power supply autosets to the applied AC voltage. No manual voltage selection is required.

The plug-in power supply comes with four primary adapters for Europe, the UK, the USA and Australia. No tools of any kind are required to change the primary adapter. The adapter is pulled out manually and another adapter inserted until it locks (Fig. 1-3).

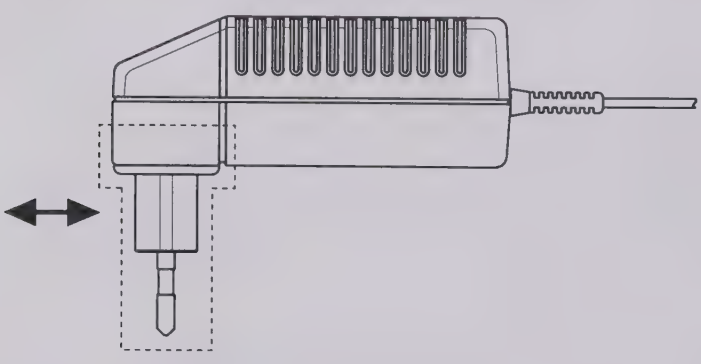

Fig. 1-3 Changing the primary adapter

The plug-in power supply is short-circuit-proof and has an internal fuse. It is not possible to replace this fuse or open the plug-in power supply.

The plug-in power supply is not intended for outdoor use.

Keep within the temperature range of 0°C to 50°C.

If there is any condensation on the plug-in power supply, dry it off before connecting it to the AC supply.

Operation via the Passive USB Adapter R&S NRP-Z4

Fig. 1-4 is a schematic of the measurement setup. The order in which the cables are connected is not critical.

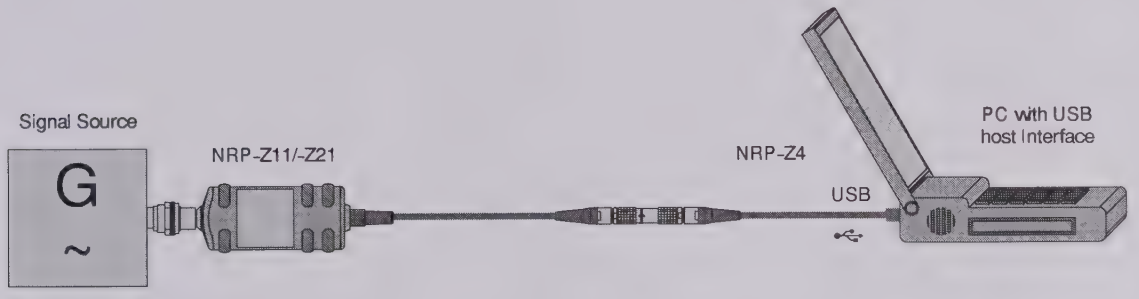

Fig. 1-4 Configuration with Passive USB Adapter R&S NRP-Z4

Connecting the sensor to the DUT

See the section "Operation with the R&S NRP basic unit" for information on how to connect the sensor to the DUT.

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2 Virtual Power Meter

You will find the **NrpFlashup** program for controlling sensors with a PC under Windows™ on the CD-ROM that accompanies the sensor. The program comprises several modules which can be started centrally via the Windows™ start-menu entry **NRP Toolkit**.

This section describes the **Power Viewer** program module. This is a virtual power meter which only uses a cut-down set of the sensor's functions. This means that after an extremely brief familiarization period, the user can measure the average power of modulated signals.

The other modules in **NrpFlashup** are described in Chapter 3 of the operating manual (**Terminal** and **Update S-Parameters** modules) or in the service manual (**Firmware Update** module).

Overview

Start the virtual power meter using the **NRP Toolkit** – **Power Viewer** start-menu entry. The **Power Viewer** program window is displayed (Fig. 2-1).

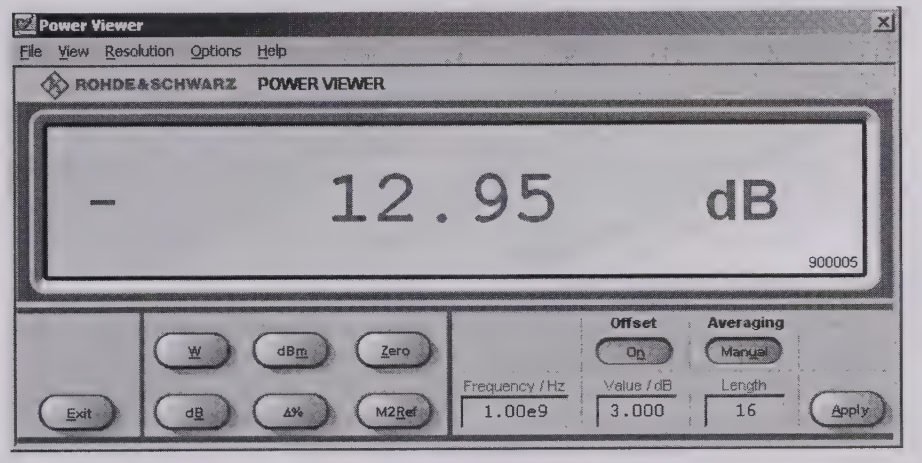


Fig. 2-1 **Power Viewer** – virtual power meter

The result display occupies most of the program window. The result, unit and additional sensor status information are displayed. The serial number of the sensor is displayed in the bottom right. The program window also contains animated buttons and entry fields (see Table 2-1 and Table 2-2).

Table 2-1 Virtual power meter keys

Button	Function	Key combination
Exit	Terminates the program. The current settings are saved and recalled the next time the program is started.	Alt + E
W	Selects Watt as the display unit.	Alt + W
dBm	Selects dBm as the display unit.	Alt + M
Zero	Zeroes the sensor.	Alt + Z
dB	Selects dB as the display unit. This is the log of the ratio of the measured value to the reference value.	Alt + B
Δ%	Selects % as the display unit. The difference between the measured value and the reference value is expressed as a percentage.	Alt + %
M2Ref	Makes the current measured value the reference value for the relative display units dB and %.	Alt + R
Offset On/Off	Turns the offset correction for the sensor on or off. If the offset correction is Off, the **Offset/dB** entry field has a grey background.	Alt + N
Averaging Man/Auto	Turns auto-averaging on or off. When auto-averaging is on, the **Length** entry field has a grey background; the current averaging factor is displayed.	Alt + T
Apply	Accepts edited numerical values in the **Frequency/Hz**, **Value/dB** and **Length** entry fields and transfers them to the sensor.	Alt + A or Enter key

Table 2-2 Virtual power meter entry fields

Entry field	Function
Frequency/Hz	Frequency of the RF carrier in Hertz.
Value/dB	Attenuation in dB of the twoport connected to the sensor. The valid range is –100 to 100. The offset correction must be activated beforehand with the **Offset On/Off** button if this entry field is to be edited.
Length	Length of the averaging filter (= averaging factor). The valid range is 1 to 65536. Averaging must be set to manual with the **Averaging Man/Auto** button if this entry field is to be edited.

Scientific notation can also be used for the entry fields. If an invalid entry is made, an error message is output. An edited numerical value will not be transferred to the sensor unless you use the **Apply** button or the Enter key to terminate the entry.

Menus

The menu bar can be used to call less frequently used functions.

File

Start Log ...

Opens a file-selection dialog to specify the path and name of the log file. Clicking the **Save** button starts the recording. All displayed values are written line-by-line to the log file with the date (format: YY/MM/DD) and time (format: hh:mm:ss.ms). Example:

```
-22.51 dBm (03/02/25 15:37:25.310)
```

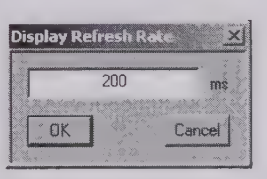
Stop Log

Ends the log-file recording.

View

Display Refresh Rate

Opens a dialog box to adjust the display refresh rate. The time in milliseconds between two refresh operations is entered. The default setting is 200 ms.



Colours

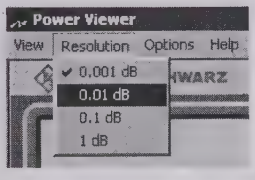
Result
Unit
Edit
Button

Opens a dialog box to select the background colour for

- the result,
- the unit,
- the text in the number fields or
- the key labelling.

Resolution

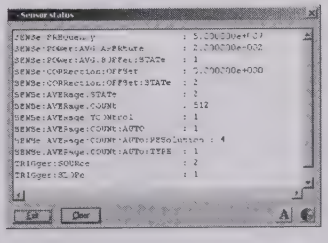
For setting the result resolution. If auto-averaging has been selected, a higher resolution leads to a greater averaging factor, which means a longer result settling time.



Options

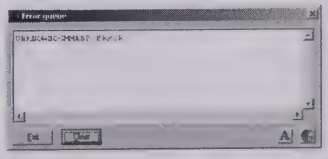
Read Sensor Status ...

Reads the current sensor status. A parameter list is output.

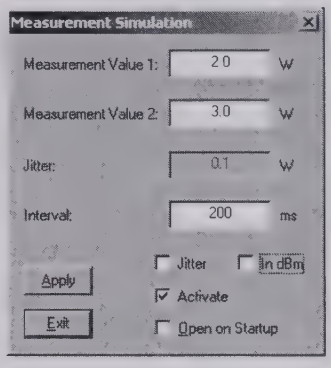


Read Error Queue ...

Reads the error queue. All the error messages that have been issued since the last call are read line-by-line. A tick before this menu entry indicates that an error has occurred.



	Simulation ...	For trying out the functions of the virtual power meter without actually connecting a sensor. The display alternates between **Measurement Value 1** & **Measurement Value 2** with a period given by **Interval**. Simulation can be activated immediately with the **Activate** check box.
	Reset Sensor	Initializes the sensor. Any previous zeroing remains valid.
Help	**Contents**	Opens the table of contents for the online-help facility.
	About	Displays information about the program version used, etc.



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3 Manual Operation

The previous section describes the Power Viewer program module supplied with the instrument. This module simplifies the most frequently used function of a power meter – measuring the average power of an RF signal of almost any modulation. Other program modules are also part of the supplied equipment and can be selected in the Start menu:

- **Power Viewer**: A detailed description of this virtual power meter module is provided in section 2.
- **Terminal**: Program module for sending commands and command sequences to the sensor and for displaying measurement results, status information and other data from the sensor
- **Firmware Update**: Program module for updating the sensor firmware
- **Update S-Parameters**: Program module for loading an s-parameter table into the sensor

Program module "Terminal"

Main control elements

With the USB terminal, commands and command sequences can be sent to the sensor in two different ways:

- Commands are entered in the **Input** field (Fig. 3-1). Consecutive commands can be entered as separate lines, one below the other. The buttons associated with the **Input** field are described in Table 3-1.
- Commands or command sequences are stored in *command files*. Command files are created with a text editor, for instance, and then stored. They can be called as often as required (Fig. 3-2). The buttons of the **Command File** field are described in Table 3-2.

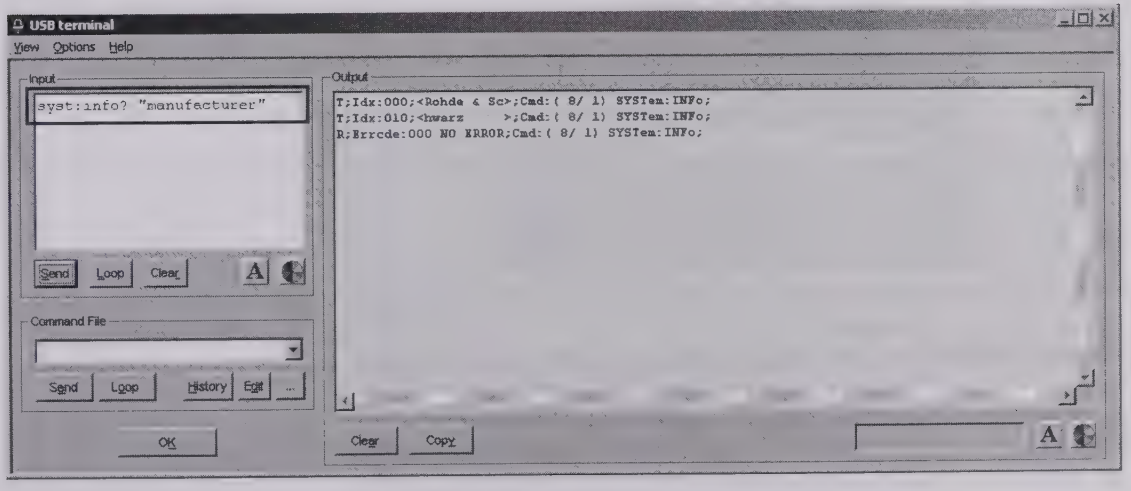


Fig. 3-1 Sending commands using the **Input** field

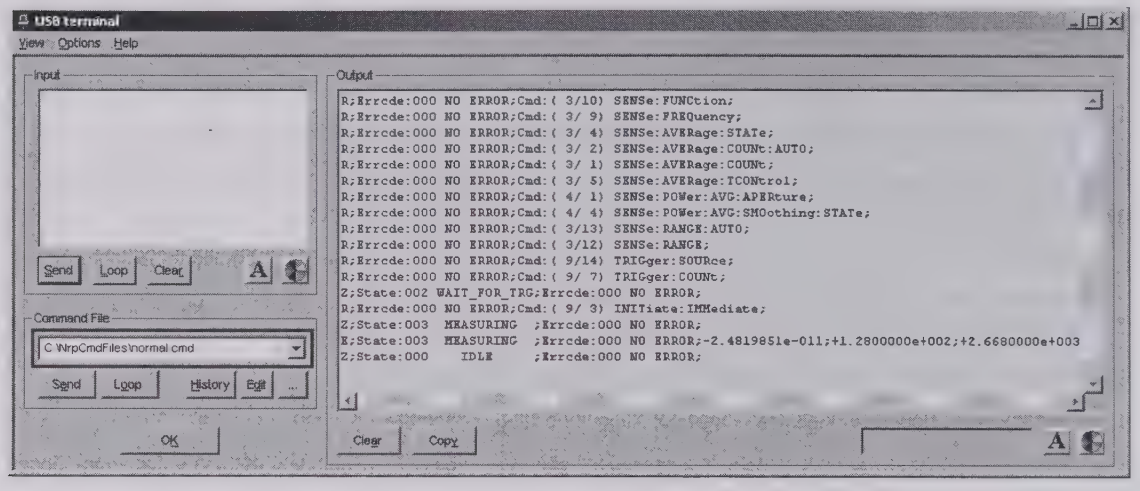


Fig. 3-2 Sending commands using command files

Table 3-1 Buttons assigned to the **Input** field

Button	Function	Key combination
Send	Sends the content of the **Input** entry field to the sensor.	Alt + S
Loop	With **Loop** the command or command sequence is cyclically sent. Pressing the button again terminates the cyclic transmission. The repetition rate is set in a dialog window that can be opened with **View - Loop...**	Alt + L
Clear	Clears the content of the **Input** field.	Alt + R
Font key	Opens a dialog window where the font for the **Input** field can be selected.	
Colour key	Opens a dialog window where the background colour of the **Input** field can be selected.	

Table 3-2 Buttons assigned to the **Command File** field

Button	Function	Key combination
Send	Sends the content of the command file to the sensor.	Alt + E
Loop	With **Loop** the command or command sequence is cyclically sent. Pressing the button again terminates the cyclic transmission. The repetition rate is set in a dialog window that can be opened with **View - Loop...**	Alt + O
History	Opens a window for editing the command file name in the **Command File** field.	Alt + H
Edit	Opens the selected command file in the Windows™ text editor.	Alt + D
...	Opens a file opening dialog for selecting the command file.	

A command line starting with a tab, a blank or a special character is considered a comment and not forwarded to the sensor.

Measurement results, parameters and status information returned by the sensor are displayed in the **Output** field.

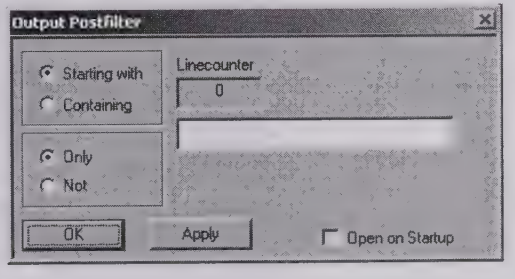
Table 3-3 Buttons assigned to the **Output** field

Button	Function	Key combination
Clear	Clears the content of the **Output** field	Alt + A
Copy	Copies the content of the **Output** field to the clipboard. (Another possiblity: mark the desired information in the output window with the mouse cursor, press the right mouse key or Ctrl+C and then copy the selected text to the clipboard using the menu item **Copy** in the opened context menu.)	Alt + Y
Font button	Opens a dialog window where the font for the **Output** field can be selected.	
Colour button	Opens a dialog window where the background colour of the **Output** field can be selected.	

Close the USB terminal with OK.

Menus

View **Post Filter ...** Opens the **Output Postfilter** dialog window where the lines stored in the input buffer can be filtered according to different criteria.



Filter criteria:

Only + **Starting with**: Only lines starting with the entered character string are displayed.

Not + **Starting with**: Only lines not starting with the entered character string are displayed.

Only + **Containing**: Only lines containing the entered character string are displayed.

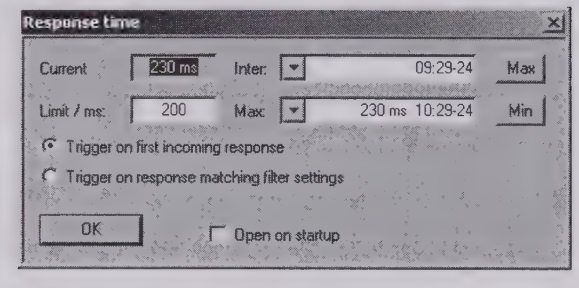
Not + **Containing**: Only lines not containing the entered character string are displayed.

Lines not matching the specific filter criterion are blanked but not cleared.

Filtering is started with **Apply**. The number of lines matching the filter criterion is displayed in the **Linecounter** field. If **Open on startup** is active, the **Output Postfilter** dialog is automatically opened when the terminal is started. The dialog window is closed with **OK**.

Response Time ...

Opens the **Response time** dialog window where the response time of the sensor can be set.



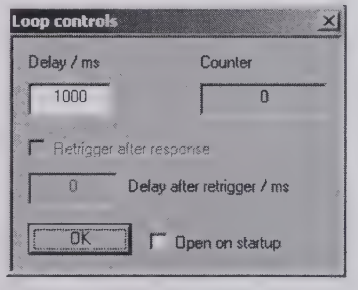
Current indicates the time elapsed between dispatch of the last command and receipt of an acknowledgement from the sensor. When the **Max** button is clicked, the response times exceeding the value in the **limit / ms** field are recorded. When the **Min** button is clicked, the response times within the value in the **limit / ms** field are recorded.

If **Trigger on first incoming response** is active, the time measurement is terminated as soon as the first response arrives after a command is sent. If **Trigger on response matching filter settings** is active, the time measurement is terminated as soon as the first response matching the filter criterion in the **Output Postfilter** dialog window is received.

If **Open on startup** is active, the **Response Time** dialog is automatically displayed when the Terminal module is started. The dialog window is closed with **OK**.

Loop ...

Opens the **Loop controls** dialog window where the cyclic transfer of commands and command sequences can be controlled.



In the **Delay / ms** field, the time interval for the cyclic transfer is specified in milliseconds.

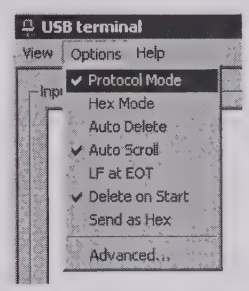
The number of completed transfer cycles is displayed in the **Counter** field. If **Open on startup** is active, the **Response time** dialog is automatically opened when the Terminal module is started. The dialog window is closed with **OK**.

Options

Protocol Mode In this mode, a time stamp is added to each response block.

Hex Mode In this mode, the response blocks from the sensor are displayed in hexadecimal format.

Auto Delete With this option active, the **Output** field is automatically cleared when the **Send** button is pressed.



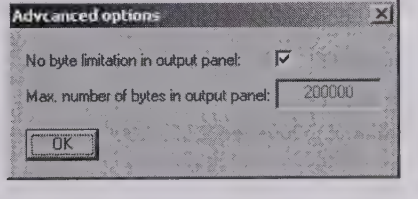
Auto Scroll With this option active, older items in the **Output** field are automatically shifted upward and off the display if space is required for new values.

LF at EOT With this option active, a line feed is appended to each response block from the sensor.

Delete on Start With this option active, the **Output** field is automatically cleared when the Terminal module is started.

Send as Hex With this option active, the text in the **Input** field is interpreted as a hexadecimal character sequence.

Advanced ... Opens a dialog window where the buffer size for the **Output** field can be set.



Help

Contents Opens the table of contents for the online help.

About Displays information about the program version, etc.

Program module "Firmware Update"

A detailed description of the program module for firmware updates is provided in the Service Manual.

Program module "Update S-Parameters"

Fundamentals

With the Sensor R&S NRP-Z11/-Z21 the influence of any twoport connected to the input on the measurement result can be corrected by way of calculation. A precondition is that a complete set of s-parameters of the twoport is available in the frequency range in question. The set of calibration data in the R&S NRP-Z11/-Z21 therefore includes an s-parameter table with up to 1000 measurement frequencies. The real and the imaginary part of each frequency as well as the uncertainty of s-parameters s_{11}, s_{12}, s_{21} and s_{22} can be stored. Since the measurement frequencies in the s-parameter table are independent of the calibration frequencies, they can be set so that the twoport frequency range of interest is optimally covered. The real and the imaginary parts between these measurement frequencies are linearly interpolated, while the more substantial measurement uncertainty at the two neighbouring frequency points is used for calculating the uncertainty of the measurement result. Below the first and above the last measurement frequency, the values of the first and the last measurement frequency are used, respectively.

The NrpFlashup program (menu item **Update S-Parameters**) is used for loading an s-parameter table. To ensure compatibility with a great number of network analyzers, NrpFlashup can process measurement data files in S2P format. All standard frequency units (Hz, kHz, MHz, GHz) and display formats (real and imaginary part, linear magnitude and phase, magnitude in dB and phase) are supported. The only restriction is that a reference impedance of 50 Ω must be used for the s-parameters. Other noise parameters in the measurement data file are not evaluated.

Structure of the S2P measurement data file:

1. The *option line* has the following format:
   # [<frequency unit>] [<parameter>] [<format>] [<R n>]
   # identifies the *option line*.
   The <frequency unit> may be Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.
   If a parameter is specified, S must be used in <parameter> for s-parameter files. If a parameter is not specified, S is implicitly assumed.
   The <format> may be MA (linear magnitude and phase in degree), DB (magnitude in dB, phase in degree) or RI (real and imaginary part). If a format is not specified, MA is implicitly assumed.
   R is optional and followed by the reference impedance in Ω. If an entry is made for R, R50 must be specified. If no entry is made, R50 is implicitly assumed.
   The *option line* should therefore read:
   # [HZ | KHZ | MHZ | GHZ] [S] [MA | DB | RI] [R 50]

2. The measurement frequencies in ascending order are specified as follows:
   $f_i \;\; s_{11}(f_i) \;\; s_{21}(f_i) \;\; s_{12}(f_i) \;\; s_{22}(f_i)$,
   where $s_{jk}(f_i)$ is the specified display format for the *option line*.

   $|s_{jk}(f_i)| \;\; \arg s_{jk}(f_i)$ (display format for linear magnitude and phase in degree) or

   $20 \cdot \lg|s_{jk}(f_i)| \;\; \arg s_{jk}(f_i)$ (display format for magnitude in dB and phase in degree)

   $\mathrm{Re}[s_{jk}(f_i)] \;\; \mathrm{Im}[s_{jk}(f_i)]$ (display format for real and imaginary part)

3. Comments: Any line starting with an exclamation mark (!) is interpreted as a comment line.

To characterize the measurement uncertainty of the s-parameter test system, another data file can optionally be created. Without this file, the measurement uncertainty cannot be correctly calculated in the sensor. The syntax of the uncertainty data file is similar to that of the S2P data file but U is specified as <Parameter> in the *option line* so that the *option line* reads # Hz U for frequencies in Hz.
The measurement frequencies must not be identical to those of the S2P measurement data files. In most cases a few entries will be sufficient to characterize the measurement uncertainty of the s-parameter test system. An s-parameter uncertainty as high as that of the neighbouring measurement frequencies of the uncertainty data file is then selected. If different values are available, the higher one is chosen. This is illustrated in the example below:

Table 3-4 Uncertainties of the s-parameter test system (example)

f in GHz	unc [$s_{ik}(f)$]
0.1	0.01
1.0	0.01
1.1	0.005
10.0	0.005
10.1	0.01
40.0	0.01

Table 3-5 Interpolated uncertainties of measurement frequencies for s-parameters (example)

f in GHz	unc [$s_{ik}(f)$]
0.9	0.01
0.95	0.01
1.0	0.01
1.05	0.01
1.1	0.005
1.15	0.005
1.2	0.005

At 1.05 GHz, the higher uncertainty of the two adjacent 1.0 GHz and 1.1 GHz measurement frequencies is entered in the s-parameter table. If an uncertainty of 0.005 is desired for all frequencies above 1.0 GHz, the first measurement frequency in the uncertainty data file must above 1.0 GHz, e.g. 1.000001 GHz.

Structure of the uncertainty data file:

1. The *option line* has the following format:
   # [<frequency unit>] <parameter> [<format>] [<R n>]
   # identifies the *option line*.
   The <frequency unit> may be Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.
   U must be specified for <parameter> in uncertainty data files. If a parameter is not specified, S is implicitly assumed and as a result an error message is triggered.
   <format> is ignored in uncertainty measurement files; the entry is therefore irrelevant.
   R is optional and followed by the reference impedance in Ω. If an entry is made for R, R50 must be specified. If no entry is made, R50 is implicitly assumed.
   The *option line* should therefore read:
   # [HZ | KHZ | MHZ | GHZ] U [MA | DB | RI] [R 50]

2. Measurement frequencies in ascending order are specified in the following form:
   $f_i \;\; \mathrm{unc}\left[s_{11}(f_i)\right] \;\; \mathrm{unc}\left[s_{21}(f_i)\right] \;\; \mathrm{unc}\left[s_{12}(f_i)\right] \;\; \mathrm{unc}\left[s_{22}(f_i)\right].$
   The s-parameters uncertainties are forwarded as follows:
   - as extended absolute uncertainties ($k = 2$) for the magnitude of reflection parameters s_{11} and s_{22}, for instance 0.015,
   - as extended uncertainties ($k = 2$) in dB for the magnitude of transmission parameters s_{21} and s_{12}, for instance 0.015.

3. Comments: Any line starting with an exclamation mark (!) is interpreted as a comment line.

Two additional values must be specified when the s-parameters are loaded: the lower and the upper nominal measurement limit of the sensor-twoport combination. If s-parameter correction is active, these values are transferred by the sensor in response to SYSTem:INFO? The values cannot always be derived from the lower or upper measurement limit of the sensor alone and from the loss or gain of the preconnected twoport. The upper measurement limit of the sensor-twoport combination may also be limited by the twoport's maximum power-handling capacity. Furthermore, the lower measurement limit may be raised not only by the loss but also by the inherent noise of the twoport. For this reason, NrpFlashup allows these values to be entered.

The upper nominal measurement limit of the sensor-twoport combination entered when loading the s-parameters should be carefully specified, as automatic test systems may evaluate it and an incorrect value may cause the sensor and/or the twoport to be overloaded.

Procedure

To load an s-parameter table into the calibration set of the sensor, proceed as follows:

1. Connect the sensor to the USB port of the PC and start NrpFlashup.
2. Activate **Update S-Parameters** in the menu. The corresponding dialog window is opened (Fig. 3-3).
3. Under **S-Parameter File** enter the search path and the name of the S2P file containing the parameters. Press the **Browse**... button to open a file-opening dialog where the S2P measurement data file can be easily selected.
4. Under **Uncertainty File** enter the search path and the name of the measurement uncertainty file containing the measurement uncertainty of the s-parameter test system. Press the **Browse**... button to open a file-opening dialog where the measurement uncertainty file can be easily selected.
5. Enter the upper and lower nominal measurement limit of the sensor-twoport combination in the **Lower Power Limit** and **Upper Power Limit** fields.
6. Enter a name for the loaded s-parameter set in the **S-Parameter Device Mnemonic** field. This name can later be queried with *SYSTem:INFO? "SPD Mnemonic"* and is displayed on the NRP basic unit when s-parameter correction is switched on.
7. Activate **S-Parameter Correction on by Default** if the *SENSe:CORRection:TRANsmission* switch should be automatically set to *ON* when the sensor is put into operation.
8. Press **Start** for loading. (The dialog is closed with **OK** and the set parameters are retained. When the dialog is exited with **Cancel**, all parameter modifications are ignored.)

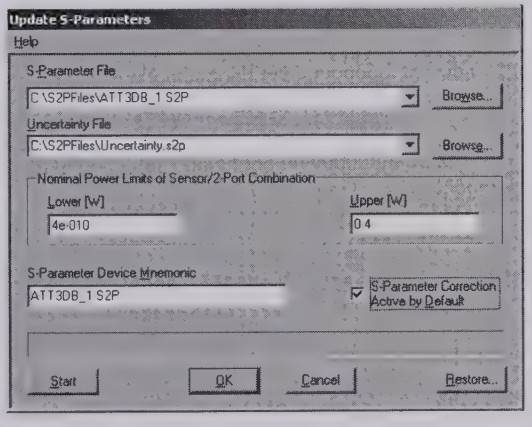


Fig. 3-3 Dialog window for loading an s-parameter table

During loading, the current calibration data set of the sensor is overwritten. To be on the safe side, a backup copy of the current calibration data set is therefore automatically stored before s-parameters are loaded. The names of the backup files have the structure <batch number>_<date><time>.bak, where <batch number> is the batch number of the sensor, <date> the date of the s-parameter update in yymmdd format and <time> the time of the s-parameter update in the format hhmmss.

Store the automatically created backup files on a separate data medium (e.g. diskette, CD-ROM or network drive) and, if required, assign an meaningful name to them to simplify reloading. With the aid of these files, a previously used calibration data set of the sensor can be restored.

To reload the backup file of a calibration data set into the sensor, proceed as follows:

- Press the **Restore...** button. The **Restore S-Parameters** window is opened (Fig. 3-4).
- Enter the search path and the name of the backup file in the **Backup File** field. Press the **Browse**... button to open a dialog where the backup file can be easily selected.
- Press **OK** to start the restore procedure. (With **Cancel** the dialog window is exited without data being restored).

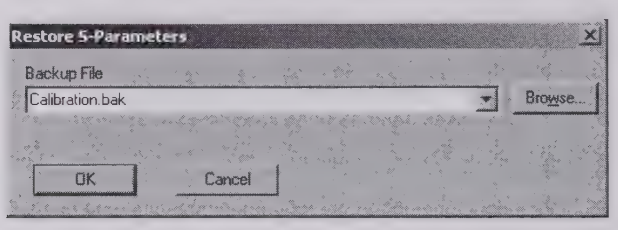


Fig. 3-4 Dialog window for loading the backup file of a calibration data set

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5 Remote Control – Fundamentals 5.1

5 Remote Control – Fundamentals

Rohde & Schwarz recommends to utilize the VXI Plug & Play Driver for the remote control of R&S NRP power sensors. This driver can be found on the CD-ROM supplied with the sensor or downloaded in its most recent version via the internet (http://rohde-schwarz.com/).

The old remote control interface provided by the *Dynamic Link Library NrpControl.dll* is not developed further, but remains on the CD-ROM and can be downloaded via the internet.

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SENSe:AVERage:COUNt:AUTO[?] OFF | ON | ONCE 6.7

SENSe:AVERage:COUNt:AUTO:MTIMe[?] 1.0 to 999.99 ..... 6.8

SENSe:AVERage:COUNt:AUTO:NSRatio[?] 0.0001 to 1.0 ..... 6.8

SENSe:AVERage:COUNt:AUTO:RESolution[?] 1 to 4 ..... 6.8

SENSe:AVERage:COUNt:AUTO:SLOT[?] 1 to <SENSe:POWer:TSLot:AVG:COUNt> 6.8

SENSe:AVERage:COUNt:AUTO:TYPE[?] RESolution | NSRatio 6.9

SENSe:AVERage:RESet 6.9

SENSe:AVERage:STATe[?] OFF | ON 6.9

SENSe:AVERage:TCONtrol[?] MOVing | REPeat 6.9

SENSe:CORRection:DCYCle[?] 0.001 to 99.999 ..... 6.10

SENSe:CORRection:DCYCle:STATe[?] OFF | ON 6.10

SENSe:CORRection:OFFSet[?] –200.0 to 200.0 ..... 6.10

SENSe:CORRection:OFFSet:STATe[?] OFF | ON 6.10

SENSe:CORRection:SPDev:STATe[?] OFF | ON 6.11

SENSe:FREQuency[?] 10.0e6 to 8.0e9 (NRP-Z11) or 18.0e9 (NRP-Z21) 6.11

SENSe:FUNCtion[?] <sensor_function> 6.12

SENSe:POWer:AVG:APERture[?] 0.0001 to 0.3 ..... 6.13

SENSe:POWer:AVG:BUFFer:SIZE[?] 1 to 1024 ..... 6.13

SENSe:POWer:AVG:BUFFer:STATe[?] OFF | ON 6.14

SENSe:POWer:AVG:SMOothing:STATe[?] OFF | ON 6.14

SENSe:POWer:BURSt:DTOLerance[?] 0.0 to 0.003 ..... 6.14

SENSe:POWer:TSLot:AVG:COUNt[?] 1 to 128 ..... 6.15

SENSe:POWer:TSLot:AVG:WIDTh[?] 0.0001 to 0.1 ..... 6.15

SENSe:RANGe[?] 0 to 2 ..... 6.15

SENSe:RANGe:AUTO[?] OFF | ON 6.16

SENSe:RANGe:AUTO:CLEVel[?] –20.0 to 0.0 ..... 6.16

SENSe:SAMPling[?] FREQ1 | FREQ2 ..... 6.16

SENSe:SGAMma:CORRection:STATe[?] OFF | ON 6.16

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SENSe:SGAMma:PHASe[?] –360.0 to 360.0 ..... 6.17
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6 Remote Control – Commands

Notation

In the following sections, all commands implemented in the sensor are first listed in a table according to command systems and are then described in detail. The notation is largely in line with the SCPI standard.

Command tables For a quick overview of available commands, the commands are listed in a table before they are described. These tables contain the following four columns:

Command:	Commands and their tree structure.
Parameters:	Possible parameters.
Unit:	The basic unit of the physical parameters (must not be sent with parameters).
Remarks:	Identification of all commands • that have no query form • that are available as query only

Indentations The various levels of the SCPI command hierarchy are shown in the table by indentations to the right. The lower the level, the greater the indentation to the right. It should be noted that the complete notation of the command includes the higher levels too.

Example:
SENSe:AVERage:COUNt is represented in the table as follows:

SENSe	first level
:AVERage	second level
:COUNt	third level

In the individual description, the command is shown in full length. An example of the command is given at the end of the description.

[?]
? A question mark in square brackets at the end of a command indicates that this command can either be used as a setting command (without question mark) or as a query (with question mark). If the question mark is not in square brackets, the command is a query only.

Example:
SENSe:POWer:AVG:APERture[?]
SENSe:POWer:AVG:APERture 1e-3 sets the length of the sampling window to 1 ms.

SENSe:POWer:AVG:APERture? Returns the currently set length as a response.
**IDN?* Queries the sensor identification string that of course cannot be changed. For this reason, this command is only available as a query.

Special characters | for parameters A vertical bar between parameters is used to separate alternative options (OR link).

Example:
NITiate:CONTinuous OFF | ON
The parameter *OFF* or *ON* can be entered.

{numeric expression} A numeric expression in braces means that it has been rounded to the nearest integral value.

<parameter>
<variable> A parameter or a variable in triangular brackets expresses its current value.

Commands as per IEEE 488.2

The sensor supports a subset of the possible setting commands and queries *(Common Commands and Queries)* in line with IEEE 488.2.

*IDN? – IDentification Query

**IDN?* returns a string with information on the sensor's identity (device identification code). In addition, the version number of the installed firmware is indicated. The string for a sensor of type R&S NRP-Z21 has the following structure:

ROHDE&SCHWARZ,NRP-Z21,<serial number>,<firmware version>

<serial number>: Serial number in ASCII
<firmware version>: Firmware version number in ASCII

*RST – Reset

**RST* sets the sensor to the default state, i.e. the default settings for all test parameters are loaded.

*TRG – Trigger

**TRG* triggers a measurement. For this purpose, the sensor is in the *WAIT_FOR_TRIGGER* state and the source for the trigger event is set to *BUS* (*TRIGger:SOURce BUS*).

*TST? – Self Test Query

**TST?* starts a selftest and returns 0 (no error found) or 1 (an error has occurred). The selftest comprises the following functions:

- RAM test
- Operating voltages
- Temperature measurement
- Calibration data set
- Noise
- Zero-point offsets.

SCPI Commands

The sensors R&S NRP-Z11/-Z21 are controlled via the groups of commands

- CALibration (zeroing)
- SENSe (measurement configurations)
- SYSTem
- TRIGger
- SERVice.

CALibration

Table 6-1 Commands of the *CALibration* system

Command	Parameter	Unit	Remarks
CALibration			
:DATA[?]	<calibration data set as definite length block>		
:LENGth?		Bytes	Query only
:ZERO			
:AUTO[?]	OFF | ON | ONCE		

CALibration:DATA[?] <calibration data set as *definite length block*>

CALibration:DATA is used for writing a calibration data set in the flash memory of the sensor.

The query yields the calibration data set currently stored in the flash memory as a *definite length block*.

CALibration:DATA:LENGth?

CALibration:DATA:LENGth? yields the length in bytes of the calibration data set currently stored in the flash memory. Programs that read out the calibration data set can use this information to determine the capacity of the buffer memory required.

CALibration:ZERO:AUTO[?] OFF | ON | ONCE

The commands *CALibration:ZERO:AUTO ON* and *CALibration:ZERO:AUTO ONCE* zeroes the three measurement paths of the sensor. For this purpose, the test signal must be deactivated or the sensor disconnected from the signal source. The sensor automatically detects the presence of any significant power to be measured. This causes zeroing to be aborted and error message *NRPERROR_CALZERO* to be output. The *CALibration:ZERO:AUTO OFF* is ignored. Zeroing takes four seconds at a minimum, but at least as long as the selected averaging filter needs for settling (only fixed-filter mode).

Repeat zeroing

- *during warm-up after switching on or connecting the instrument*
- *after a substantial variation of the ambient temperature*
- *after fastening the sensor to an RF connector at high temperature*
- *after several hours of operation*
- *when very low-power signals are to be measured, e.g. less than 10 dB above the lower measurement limit.*

For zeroing switch off the test signal and do not remove the sensor from the signal source. Apart from keeping the thermal balance, this has the advantage that the noise superimposed on the test signal (e.g. from a broadband amplifier) can be detected on zeroing and does not impair the measurement result.

The query always yields *1* (= *OFF*).

Default setting
After a power-on reset, the zero offsets determined during the last calibration are used until the first zeroing. Therefore, very slight zero offsets are to be expected with a warmed up sensor. Initialization by means of **RST* or *SYSTem:INITialize* has no influence on the current zero offsets.

SENSe (Sensor Configuration)

The sensor is configured by means of the commands of the groups *SENSe* and *TRIGger*.

Table 6-2 Commands of the *SENSe* system

Command	Parameter	Unit	Remarks
SENSe			
:AVERage			
:RESet			No query
:STATe[?]	OFF | ON		
:TCONtrol[?]	MOVing | REPeat		
:COUNt[?]	1 to 65536		
:AUTO[?]	OFF | ON | ONCE		
:TYPE[?]	RESolution | NSRatio		
:MTIMe[?]	1.0 to 999.99	s	
:NSRatio[?]	0.0001 to 1.0	dB	
:RESolution[?]	1 to 4		
:SLOT[?]	1 to <SENSe:POWer:TSLot:AVG:COUNt>		
:CORRection			
:OFFSet[?]	-200.0 to 200.0	dB	
:STATe[?]	OFF to ON		
:DCYCle[?]	0.001 to 99.999	%	
:STATe[?]	OFF to ON		
:SPDevice:STATe[?]	OFF to ON		
:FREQuency[?]	10.0e6 to 8.0e9 (NRP-Z11) or 18.0e9 (NRP-Z21)	Hz	
:FUNCtion[?]	"POWer:AVG" | "POWer:TSLot:AVG" | "POWer:BURSt:AVG" | "XTIME:POWer"		
:POWer			
:AVG			
:APERture[?]	1.0e-6 to 0.3	s	
:BUFFer			
:STATe[?]	OFF | ON		
:SIZE[?]	1 to 1024		

Command	Parameter	Unit	Remarks
:SMOothing:STATe[?]	OFF | ON		
:BURSt:DTOLerance[?]	0.0 to 3.0e-3	s	
:TSLot:AVG			
:COUNt[?]	1 to 128		
:WIDTh[?]	10e-6 to 100e-3	s	
:RANGe [?]	0 to 2		
:AUTO[?]	OFF | ON		
:CLEVel[?]	0.0 to 20.0	dB	
:SAMPling[?]	FREQ1 | FREQ2		
:SGAMma			
:CORRection:STATe[?]	OFF | ON		
:MAGNitude[?]	0.0 to 1.0		
:PHASe[?]	-360.0 to 360.0	degree	
:TRACe			
:AVERage			
:STATe[?]	OFF | ON		
:TCONtrol[?]	MOVing | REPeat		
:COUNt[?]	1 to 65536		
:AUTO[?]	OFF | ON | ONCE		
TYPE[?]	RESolution | NSRatio		
:MTIMe[?]	1.0 to 999.99	s	
:NSRatio[?]	0.0001 to 1.0	dB	
:RESolution[?]	1 to 4		
:POINt[?]	1 to <SENSe:TRACe:POINts>		
:MPWidth?		s	Query only
:OFFSet:TIME[?]	– (<TRIGger:DELay> + 0.005) to 100.0	s	
:POINts[?]	1 to 1024		
:REALtime[?]	OFF | ON		

Command	Parameter	Unit	Remarks
:TIME[?]	0.0001 to 0.3		
:TIMing			
:EXCLude			
:STARt[?]	0.0 to 3.0e-3	s	
:STOP[?]	0.0 to 3.0e-3	s	

SENSe:AVERage:COUNt[?] 1 to 65536

SENSe:AVERage:COUNt sets the number of measured values that have to be averaged for forming the measurement result in the modes *Continuous Average*, *Burst Average* and *Timeslot*. The higher this averaging factor, the less the measured values fluctuate and the longer the measurement time lasts. The parameter is rounded off to the nearest power-of-two number.

The query yields the averaging factor used in the modes *Continuous Average*, *Burst Average* and *Timeslot*.

The averaging function must be activated with SENSe:AVERage:STATe ON *so that the set averaging factor becomes effective.*

Default setting: *4*

SENSe:AVERage:COUNt:AUTO[?] OFF | ON | ONCE

SENSe:AVERage:COUNt:AUTO activates (auto-averaging) or deactivates (fixed-filter mode) automatic determination of the averaging factor in the modes *Continuous Average*, *Burst Average* and *Timeslot*. If auto-averaging is activated, the averaging factor is continuously determined and set depending on the level of power and other parameters.

SENSe:AVERage:COUNt:AUTO ON activates auto-averaging and *SENSe:AVERage:COUNt :AUTO OFF* deactivates it. On deactivation, the previous, automatically determined averaging factor is used in the fixed-filter mode. The *SENSe:AVERage:COUNt:AUTO ONCE* command ensures that a new averaging factor is determined by the filter automatic function under the current measurement conditions and used in the fixed-filter mode.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *OFF*

SENSe:AVERage:COUNt:AUTO:MTIMe[?] 1.0 to 999.99

SENSe:AVERage:COUNt:AUTO:MTIMe sets the settling time upper limit of the averaging filter in the auto-averaging mode for the *Continuous Average*, *Burst Average* and *Timeslot* modes and limits the length of the filter.

The query yields the current settling time upper limit of the averaging filter in the auto-averaging mode for the *Continuous Average*, *Burst Average* and *Timeslot* modes.

Default setting: *30.0 [s]*

SENSe:AVERage:COUNt:AUTO:NSRatio[?] 0.0001 to 1.0

SENSe:AVERage:COUNt:AUTO:NSRatio determines the relative noise component in the measurement result for the *Continuous Average*, *Burst Average* and *Timeslot* modes if auto-averaging is operated in the corresponding mode (*SENSe:AVERage:COUNt:AUTO:TYPE NSRatio*). The noise component is defined as the magnitude of the level variation in dB caused by the inherent noise of the sensor (two standard deviations).

The query yields the relative noise component in the result for the *Continuous Average*, *Burst Average* or *Timeslot* modes.

Default setting: *0.01 [dB]*

SENSe:AVERage:COUNt:AUTO:RESolution[?] 1 to 4

SENSe:AVERage:COUNt:AUTO:RESolution sets the resolution index for the automatic averaging filter in the *Continuous Average*, *Burst Average* and *Timeslot* modes if it is operated in the *RESolution* mode. The resolution index equals the number of decimal places that have to be taken into account for the further processing of the measurement result in dBm, dBµV or dB. The normal mode is designed in a similar manner as for the predecessors R&S NRVS and R&S NRVD or other commercial power meters. The higher the selected index, the better the measurement result is filtered without the last significant place (0.01 dB with an index of 3) actually being set. The NSRatio setting is recommended instead.

The query yields the resolution index for the *Continuous Average*, *Burst Average* and *Timeslot* modes.

Default setting: *3*

SENSe:AVERage:COUNt:AUTO:SLOT[?] 1 to <SENSe:POWer:TSLot:AVG:COUNt>

SENSe:AVERage:COUNt:AUTO:SLOT defines the timeslot, whose power is referenced by auto-averaging in the *Timeslot* mode. The timeslot is addressed via its number, the counting beginning with 1. The timeslot number must not exceed the number of the currently set timeslots. If a valid timeslot number is initially set and then the number of timeslots reduced to a value that is smaller than the initial timeslot number, the initial value is automatically set to the new timeslot number, i.e. auto-averaging references the most recent timeslot.

The query yields the number of the current timeslot, whose power is referenced by auto-averaging in the *Timeslot* mode.

Default setting: *1*

SENSe:AVERage:COUNt:AUTO:TYPE[?] RESolution | NSRatio

SENSe:AVERage:COUNt:AUTO:TYPE defines the automatic averaging filter mode in the *Continuous Average*, *Burst Average* and *Timeslot* modes. The *RESolution* parameter sets the mode usual for power meters; *NSRatio* predefines the compliance to an exactly defined noise component.

The query yields
- *1* for *RESolution*,
- *2* for *NSRatio*.

Default setting: *RESolution*

SENSe:AVERage:RESet

SENSe:AVERage:RESet initializes the averaging filter for the *Continuous Average*, *Burst Average* or *Timeslot* modes. This is useful if a high averaging factor is set in the *SENSe:AVERage :TCONtrol MOVing* filter mode and if the power to be measured has significantly decreased since the previous measurement, e.g. by several powers of ten. In this case, previous measurement results still contained in the averaging filter strongly affect the settling of the display; as a result, the advantage of the *SENSe:AVERage:TCONtrol MOVing* filter mode, i.e. the ability to detect trends in the measurement result while the measurement is still in progress, is lost. The *SENSe:AVERage:RESet* command solves this problem by deleting all previous measurement results that the averaging filter contains. After initialization, the filter length gradually increases from 1 to its nominal value *SENSe:AVERage:COUNt*, so that trends in the measurement result become quickly apparent. However, this procedure does not shorten the measurement time required in order for the averaging filter to settle completely.

SENSe:AVERage:STATe[?] OFF | ON

SENSe:AVERage:STATe switches on or off the averaging filter for the *Continuous Average*, *Burst Average* and *Timeslot* modes.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *ON*

SENSe:AVERage:TCONtrol[?] MOVing | REPeat

SENSe:AVERage:TCONtrol (terminal control) defines the behaviour of the averaging filter in the *Continuous Average*, *Burst Average* and *Timeslot* modes. As soon as a new measured value is shifted to the FIR filter, a new average value is available at the filter output, which is obtained from the new measured value and the other values stored in the filter.

The *MOVing* parameter defines that each new average value is output as a measurement result. This allows tendencies in the result to be recognized during the measurement procedure.

The *REPeat* parameter defines that a new result is output after the FIR filter has been filled with new measured values. This ensures that no redundant information is output.

The query yields
- *1* for *MOVing*,
- *2* for *REPeat*.

Default setting: *MOVing*

SENSe:CORRection:DCYCle[?] 0.001 to 99.999

SENSe:CORRection:DCYCle sets the duty cycle to a percent value for the correction of pulse-modulated signals. With the correction activated, the sensor calculates the signal pulse power from this value and the mean power. Since the duty cycle is only useful in the Continuous Average mode and the normal mode, it is evaluated only there.

The query yields the current duty cycle in percent.

Default setting: *1.0 [%]*

SENSe:CORRection:DCYCle:STATe[?] OFF | ON

SENSe:CORRection:DCYCle:STATe ON activates the duty cycle correction and thus the pulse-power measurement whereas *SENSe:CORRection:DCYCle:STATe OFF* deactivates it.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:CORRection:OFFSet[?] –200.0 to 200.0

SENSe:CORRection:OFFSet defines a fixed offset in dB, which is used to correct the measured value. (When a log scale is used, the offset is added to the measured value; this is the reason why the command has this name.)

The attenuation of an attenuator located ahead of the sensor or the coupling attenuation of a directional coupler is taken into account with a positive offset, i.e. the sensor calculates the power at the input of the attenuator or directional coupler. A negative offset can be used to correct the influence of a gain connected ahead.

The query yields the set offset in dB.

Default setting: *0.0 [dB]*

SENSe:CORRection:OFFSet:STATe[?] OFF | ON

SENSe:CORRection:OFFSet:STATe ON activates the offset correction and
SENSe:CORRection:OFFSet:STATe OFF deactivates it.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:CORRection:SPDev:STATe[?] OFF | ON

SENSe:CORRection:SPDevice:STATe ON activates the s-parameter data set for a component (attenuator, directional coupler) connected ahead of the sensor. Parameter *OFF* deactivates it.

The use of s-parameters instead of a fixed offset
(see group of commands *SENSe:CORRection:OFFSet*)
allows more precise measurements, since the interactions between the sensor, the source and components connected between them can be taken into account. (For detailed information on loading s-parameter data sets, refer to section 3.) The sensor has no factory-set s-parameter data set. In this state, the *SENSe:CORRection:SPDevice:STATe ON* command generates an error message.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting:
The factory-set default setting of the sensor is *OFF.* On loading an s-parameter table, the default setting can be redefined (see section 3).

SENSe:FREQuency[?] 10.0e6 to 8.0e9 (NRP-Z11) or 18.0e9 (NRP-Z21)

SENSe:FREQuency transfers the carrier frequency of the RF signal to be measured; this frequency is used for the frequency-response correction of the measurement result. The center frequency is set for broadband signals (*spread-spectrum* signals, multicarrier signals).

The query yields the set carrier frequency in Hz.

Default setting: *50.0e6 [Hz]*

SENSe:FUNCtion[?] <sensor_function>

SENSe:FUNCtion <sensor_function> sets the sensor to one of the following measurement modes:

Table 6-3 Measurement modes

<sensor_function>	Description of the measurement mode
"POWer:AVG"	**Continuous Average** After occurrence of the trigger event, the mean power is measured in a time interval (sampling window) whose width is defined with SENSe:POWer:AVG:APERture. The single measurements are performed in pairs to obtain a more accurate measurement result by differentiation. With the averaging function activated, this operation is repeated the number of times specified by the averaging factor. With the averaging function activated, the actual measurement time is thus 2 × <SENSe:AVERage:COUNt> × <SENSe:POWer:AVG:APERture> and with deactivated averaging function 2 × <SENSe:POWer:AVG:APERture>. Trigger events start one or several measurements in the Continuous Average mode (depending on the TRIGger:COUNt parameter).
"POWer:TSLot:AVG"	**Timeslot** The power is measured in a defined number of consecutive timeslots. Up to 128 timeslots have the same width, which is defined by SENSe:POWer:TSLot :WIDTh. Their quantity is defined by SENSe:POWer:TSLot:COUNt. The measurement result is an array, which contains as many elements as timeslots. Each element represents the average power in one of the timeslots. After each occurrence of the trigger event, a measurement is performed in all timeslots. The single measurements are also performed in pairs in this mode to obtain a more accurate measurement result by differentiation. With the averaging function activated, this operation is repeated the number of times specified by the averaging factor. With the averaging function activated, the actual measurement time is thus 2 × <SENSe:AVERage:COUNt> × <SENSe:POWer:TSLot:AVG:WIDTh> and with deactivated averaging function 2 × <SENSe:POWer:TSLot:AVG:WIDTh>. Note that a corresponding number of trigger events must be available.
"POWer:BURSt:AVG"	**Burst Average** This mode is used for the measurement of the average power of repetitive single bursts, for example. The time interval (integration time) in which the average power is measured is not predefined. Instead, a special algorithm detects the beginning and end of the burst and ensures the synchronization of the sampling window. However, the user must define the dropout tolerance, a time criterion for detecting the pulse or burst end, using SENSe:POWer:BURSt:DTOLerance. In the Burst Average mode, external trigger events (irrespective of the setting of the TRIGger:SOURce parameter) and the TRIGger:DELay parameter are ignored.
"XTIMe:POWer"	**Scope** The Scope mode is similar to the Timeslot mode. Since, however, up to 1024 consecutive timeslots (called "points" here) are possible, the maximum averaging factor is limited to 8192 due to the storage capacity. In the Scope mode, other limits than in the Timeslot mode apply to the timeslot width. SENSe:TRACe:REALtime ON optimizes the time resolution. The differentiation and averaging filter are ignored.

Time intervals that are excluded from the measurement can be set at the beginning and the end of the sampling window or timeslot in the measurement modes *Burst Average* and *Timeslot*. (*SENSe:TIMing:EXCLude:STARt* and *-:STOP*).

The query yields
- *1* for *"POWer:AVG"*,
- *2* for *"POWer:TSLot:AVG"*,
- *4* for *"POWer:BURSt:AVG"*,
- *8* for *"XTIMe:POWer"*.

Default setting: *"POWer:AVG"*

SENSe:POWer:AVG:APERture[?] 0.0001 to 0.3

SENSe:POWer:AVG:APERture defines the time interval (sampling window) for the *Continuous Average* mode; measured values are continuously recorded in this interval. In manual operation, the default setting of 20 ms in conjunction with the activated smoothing (see *SENSe:POWer:AVG:SMOothing:STATe*) is sufficient in most cases. Another value, which is normally higher, is required when the measurement result shows variations due to modulation. Especially with low-frequency modulation, it is useful to adapt the size of the sampling window exactly to the modulation period, which yields an optimum stable display.

Table 6-4 Optimum selection of the sampling window size (N = 1, 2, 3, ...)

Smoothing	Optimum sampling window size
OFF	N × modulation period / 2
ON	N × modulation period × 2

The theoretically shortest measurement time can then be obtained only with smoothing deactivated. As the number of modulation periods that fit into a sampling window increases, the issue of whether N is an integer becomes more critical. With smoothing activated, approx. 5 periods are sufficient to reduce variations due to modulation to an acceptable extent; variations are no longer perceptible with more than 9 periods. With smoothing deactivated, the situation is significantly unfavourable. In this case, 5 instead of 300 periods are required and the variations completely disappear as of 3000 periods.

The query yields the currently set width of the sampling window in seconds.

Default setting: *0.02 [s]*

SENSe:POWer:AVG:BUFFer:SIZE[?] 1 to 1024

SENSe:POWer:AVG:BUFFer:SIZE sets the buffer size for the buffered *Continuous Average* mode.

The query yields the current buffer size for the buffered *Continuous Average* mode.

Default setting: *1*

SENSe:POWer:AVG:BUFFer:STATe[?] OFF | ON

The buffered *Continuous Average* mode is activated with *ON* and deactivated with *OFF*. In this mode, the results generated by trigger events are collected in the sensor until the buffer is filled. All results are then transferred as block data. The measurement rate obtained is thus higher than in the non-buffered *Continuous Average* mode. The maximum measurement rate is obtained by combining the buffered mode with multiple triggering (see parameter *TRIGger:COUNt*). The size of the result buffer is set with the *SENSe:POWer:AVG:BUFFer:SIZe* command.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:POWer:AVG:SMOothing:STATe[?] OFF | ON

The *ON* parameter activates a smoothing filter for modulated signals in the *Continuous Average* mode and *OFF* deactivates it. The smoothing filter is a steep-edge digital lowpass filter used to suppress variations of results caused by low-frequency modulation. This parameter should be activated to reduce variations in results due to modulation when the size of the sampling window cannot or should not be exactly adapted to the modulation period. If the selected sampling window is 5 to 9 times larger than a modulation period, the variations in display are normally sufficiently reduced. With smoothing deactivated, 300 to 3000 periods are required to obtain the same effect.

With smoothing deactivated, the sampling values are considered equivalent and averaged in a sampling window, which yields an integrating behaviour of the measuring instrument. As described above, optimum suppression of variations in the result is thus obtained when the size of the sampling window is exactly adapted to the modulation period. Otherwise, the modulation can have a considerable influence, even if the sampling window is much larger than the modulation period. The behaviour can be considerably improved by subjecting sampling values to weighting (raised-von-Hann window), which corresponds to video filtering. This is exactly what happens with activated smoothing.

Since the smoothing filter increases the inherent noise of the sensor by approx. 20%, it should remain deactivated if it is not required.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *ON*

SENSe:POWer:BURSt:DTOLerance[?] 0.0 to 0.003

SENSe:POWer:BURSt:DTOLerance defines the dropout tolerance, a parameter for reliably detecting the burst end in the *Burst Average* mode with modulated signals (e. g. with digital standards NADC, PDC, PHS, etc.). The dropout tolerance should be selected larger than the longest amplitude drop and smaller than the gap between two consecutive bursts. The default value is sufficient for all usual digital communication standards.

The query yields the dropout tolerance for the *Burst Average* mode.

Default setting: *0.0001 [s]*

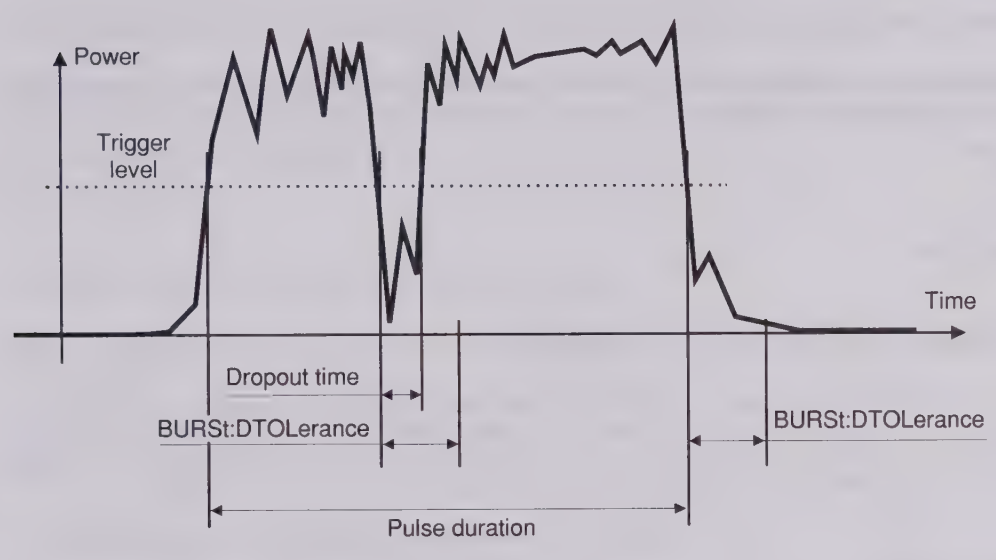

Fig. 6-1 Effect of SENSe:POWer:BURSt:DTOLerance

SENSe:POWer:TSLot:AVG:COUNt[?] 1 to 128

For the Timeslot mode, *SENSe:POWer:TSLot:AVG:COUNt* sets the number of consecutive timeslots that are to be processed after each trigger event.

The query yields the number of consecutive timeslots.

Default setting: *1*

SENSe:POWer:TSLot:AVG:WIDTh[?] 0.0001 to 0.1

SENSe:POWer:TSLot:AVG:WIDTh sets the length of a timeslot in seconds for the Timeslot mode.

The query yields the length of a timeslot in seconds for the Timeslot mode.

Default setting: *0.001 [s]*

SENSe:RANGe[?] 0 to 2

SENSe:RANGe selects the measurement path of the sensor. The sensor has three separate measurement paths. Path 1 is the most sensitive, path 2 medium and path 3 the least sensitive. *SENSe:RANGe 0* selects path 1, *SENSe:RANGe 1* path 2 and *SENSe:RANGe 2* path 3.
The dynamic ranges of these measurement paths depend on temperature and are model-specific. Reference values are 40 µW(–14 dBm) for the most sensitive measurement path, 4 mW (6 dBm) for the medium one and 400 mW (26 dBm) for the least sensitive.

The query yields
- *0* for path 1,
- *1* for path 2,
- *2* for path 3.

If the measurement path is selected manually (*SENSe:RANGe:AUTO OFF*), the currently selected measurement path is output. With automatic selection, the last path that was set manually is output. It is therefore immediately reset after deactivating the automatic function.

Default setting: *2* (least sensitive path)

SENSe:RANGe:AUTO[?] OFF | ON

SENSe:RANGe:AUTO ON activates the automatic selection of the measurement path and *SENSe:RANGe:AUTO OFF* deactivates it.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *ON*

SENSe:RANGe:AUTO:CLEVel[?] –20.0 to 0.0

SENSe:RANGe:AUTO:CLEVel is used to reduce the transition range between measurement paths 1 and 2 or 2 and 3 by the indicated value (in dB). This can improve the measurement accuracy for signals with a high *peak-to-average* ratio, since the headroom for modulation peaks becomes larger. The disadvantage is that the S/N ratio is reduced at the lower limits of the transition ranges.

The query yields the offset of transition ranges between measurement channels 1 and 2 or 2 and 3.

Default setting: *0.0 [dB]*

SENSe:SAMPling[?] FREQ1 | FREQ2

SENSe:SAMPling is used to vary the sampling frequency of the analog-digital converter in the sensor. With parameter specification *FREQ1* the sampling frequency is 133.400 kHz, and 119.467 kHz with parameter *FREQ2.* This is provided to suppress interfering low-frequency mixture products from signal components and the sampling frequency.

The query yields
- *1* for *FREQ1,*
- *2* for *FREQ2.*

Default setting: *FREQ1*

SENSe:SGAMma:CORRection:STATe[?] OFF | ON

SENSe:SGAMma:CORRection:STATe ON initiates the use of the complex reflection coefficient of the source defined with *SENSe:SGAMma:MAGNitude* and *SENSe:SGAMma:PHASe* for the correction of interactions between the sensor, the source and the components connected between them (*see SENSe:CORRection:SPDevice:STATe*). This compensates for the source mismatch, which often largely contributes to measurement uncertainty.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:SGAMma:MAGNitude[?] 0.0 to 1.0

SENSe:SGAMma:MAGNitude defines the magnitude of the complex reflection coefficient of the source. A value of *0.0* corresponds to an ideal matched source and a value of 1.0 to total reflection.

The query yields the set magnitude.

Default setting: *0.0*

SENSe:SGAMma:PHASe[?] –360.0 to 360.0

SENSe:SGAMma:MAGNitude defines the phase angle (in degrees) of the complex reflection coefficient of the source.

The query yields the set phase angle.

Default setting: *0.0 [°]*

SENSe:TRACe:AVERage:COUNt[?] 1 to 65536

SENSe:TRACe:AVERage:COUNt is used to set the number of measured values to be averaged in the *Scope* mode for the formation of the measurement result. The higher this averaging factor, the lesser the fluctuation the measured values and the longer the measurement time. The parameter is rounded off to the next power-of-two number.

The query yields the averaging factor used in the *Scope* mode.

The averaging function must be activated with SENSe:TRACe:AVERage:STATe ON so that the set averaging factor becomes effective.

Default setting: *4*

SENSe:TRACe:AVERage:COUNt:AUTO[?] OFF | ON | ONCE

SENSe:SWep:AVERage:COUNt:AUTO activates (auto-averaging) or deactivates (fixed-filter mode) the automatic determination of the averaging factor in the *Scope* mode. If auto-averaging is activated, the averaging factor is continuously determined and set depending on the level of power and other parameters.

SENSe:TRACe:AVERage:COUNt:AUTO ON activates auto-averaging and *SENSe:TRACe :AVERage:COUNt:AUTO OFF* deactivates it. When deactivation occurs, the previous, automatically determined averaging factor is used in the fixed-filter mode. The *SENSe:TRACe:AVERage :COUNt:AUTO ONCE* command ensures that a new averaging factor is determined by the filter automatic function under the current measurement conditions and that this factor is used in the fixed-filter mode.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *OFF*

SENSe:TRACe:AVERage:COUNt:AUTO:MTIMe[?] 1.0 to 999.99

SENSe:TRACe:AVERage:COUNt:AUTO:MTIMe sets the settling time upper limit of the averaging filter in the auto-averaging mode for the *Scope* mode and limits the length of the filter.

The query yields the current settling time upper limit of the averaging filter in the auto-averaging mode for the *Scope* mode.

Default setting: *30.0 [s]*

SENSe:TRACe:AVERage:COUNt:AUTO:NSRatio[?] 0.0001 to 1.0

SENSe:TRACe:AVERage:COUNt:AUTO:NSRatio determines the relative noise component in the measurement result for the *Scope* mode if auto-averaging is operated in the corresponding mode (*SENSe:TRACe:AVERage:COUNt:AUTO:TYPE NSRatio*). The noise component is defined as the magnitude of the level variation in dB caused by the inherent noise of the sensor (two standard deviations).

The query yields the relative noise component in the measurement result in the *Scope* mode.

Default setting: *0.01 [dB]*

SENSe:TRACe:AVERage:COUNt:AUTO:RESolution[?] 1 to 4

SENSe:TRACe:AVERage:COUNt:AUTO:RESolution sets the resolution index for the automatic averaging filter in the *Scope* mode when it is operated in the *RESolution* mode. The resolution index is equal to the number of decimal places that have to be taken into account for the further processing of the measurement result in dBm, dBµV or dB. Thus, the design of the normal mode is similar to that for the predecessors R&S NRVS and R&S NRVD or other commercial power meters. The higher the selected index, the better the measurement result is filtered without the last significant place (0.01 dB with an index of 3) being actually set. The NSRatio setting is recommended instead.

The query yields the resolution index for the *Scope* mode.

Default setting: *3*

SENSe:TRACe:AVERage:COUNt:AUTO:POINt[?] 1 to <SENSe:TRACe:POINts>

SENSe:TRACe:AVERage:COUNt:AUTO:SLOT defines the "point" whose power is referenced by auto-averaging in the *Scope* mode. The "point" is addressed via its number, the counting beginning with 1. The "point" number must not exceed the number of the currently set "points". If a valid "point" number is initially set and then the number of "points" reduced to a value that is smaller than the initial "point" number, the initial value is automatically set to the new "point" number, i.e. auto-averaging references the most recent "point".

The query yields the number of the current "point" whose power is referenced by auto-averaging in the *Scope* mode.

Default setting: *1*

SENSe:TRACe:AVERage:COUNt:AUTO:TYPE[?] RESolution | NSRatio

SENSe:TRACe:AVERage:COUNt:AUTO:TYPE defines the mode of the automatic averaging filter in the *Scope* mode. The *RESolution* parameter sets the mode usual for power meters; *NSRatio* predefines the compliance to an exactly defined noise component.

The query yields
- 1 for *RESolution*,
- 2 for *NSRatio*.

Default setting: *RESolution*

SENSe:TRACe:AVERage:STATe[?] OFF | ON

SENSe:TRACe:AVERage:STATe switches the averaging filter on or off for the *Scope* mode.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *ON*

SENSe:TRACe:AVERage:TCONtrol[?] MOVing | REPeat

SENSe:TRACe:AVERage:TCONtrol (terminal control) defines the behaviour of the averaging filter in the *Scope* mode. As soon as a new measured value is shifted to the FIR filter, a new mean is available at the filter output, which is obtained from the new measured value and the other values stored in the filter.

The *MOVing* parameter defines that each new average value is output as a measurement result. This allows trends in the result to be recognized during the measurement procedure.

The *REPeat* parameter defines that a new result is output after the FIR filter has been filled with new measured values. This ensures that no redundant information is output.

The query yields
- *1* for *MOVing*,
- *2* for *REPeat*.

Default setting: *MOVing*

SENSe:TRACe:MPWidth?

SENSe:TRACe:MPWidth? provides the *minimum point width* for the *Scope* mode, i.e. time resolution in seconds is determined as a function of the *TRIGger:SOURce* parameter while taking into consideration how the sensor operates. The display may be incorrect if

<SENSe:TRACe:POINts> × <SENSe:TRACe:MPWidth> < SENSe:TRACE:TIME>

One way to prevent this is to decrease the number of points of the *Scope* measurement sequence.

SENSe:TRACe:OFFSet:TIME[?] – (<TRIGger:DELay> + 0.005) to 100.0

This command is used to shift the timeslot for measured-data acquisition along the time axis in the *Scope* mode without modifying the value of *TRIGger:DELay*. Positive values yield an additional delay and negative values a correspondingly earlier measured-data acquisition.

The query yields the set time in seconds.

Default setting: *0.0 [s]*

SENSe:TRACe:POINts[?] 1 to 1024

This command defines the time resolution of the measurement result. Each "point" represents a time interval whose duration is obtained from the length of the timeslot (command *SENSe:TRACe:TIME*) divided by the number of "points". The measurement result for a "point" equals the average power over the associated time interval.

The query yields the number of set "points".

Default setting: *100*

SENSe:TRACe:REALtime[?] OFF | ON

SENSe:TRACe:REALtime ON suppresses the measured-value acquisition in pairs so that single operations can be recorded in this setting. Since the averaging filter of the sensor is not used, *SENSe:AVERage:STATe* is ignored, but is not affected.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:TRACe:TIME[?] 0.0001 to 0.3

SENSe:TRACe:TIME sets the duration of the timeslot in the *Scope* mode. This timeslot is divided into a number of equal intervals, in which the average power is determined. The number of intervals equals the number of test points, which is set with the command *SENSe:TRACe:POINts.*

The query yields the duration of the timeslot in the *Scope* mode (in s).

Default setting: *0.01 [s]*

SENSe:TIMing:EXCLude:STARt[?] 0.0 to 0.1

SENSe:TIMing:EXClude:STARt defines the exclusion time at the beginning of the measurement window in the *Burst Average* (Fig. 6-2) and *Timeslot* (Fig. 6-3) modes.

The query yields the exclusion time at the beginning of the measurement window.

Default setting: *0.0 [s]*

SENSe:TIMing:EXCLude:STOP[?] 0.0 to 0.003

SENSe:TIMing:EXClude:STOP defines the exclusion time at the end of the measurement window in the *Burst Average* (Fig. 6-2) and *Timeslot* (Fig. 6-3) modes.

The query yields the exclusion time at the end of the measurement window.

Default setting: *0.0 [s]*

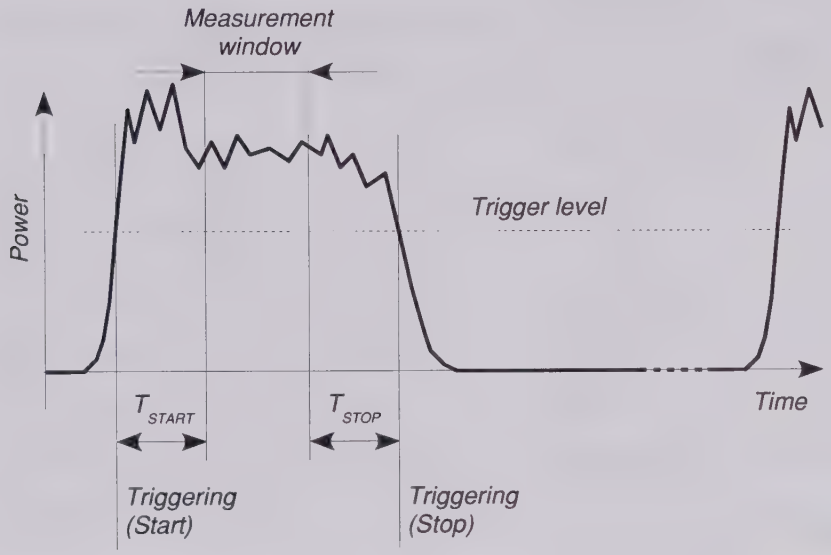

Fig. 6-2 Effect of *SENSe:TIMing:EXCLude:STARt* and *:END* in the *Burst Average* mode

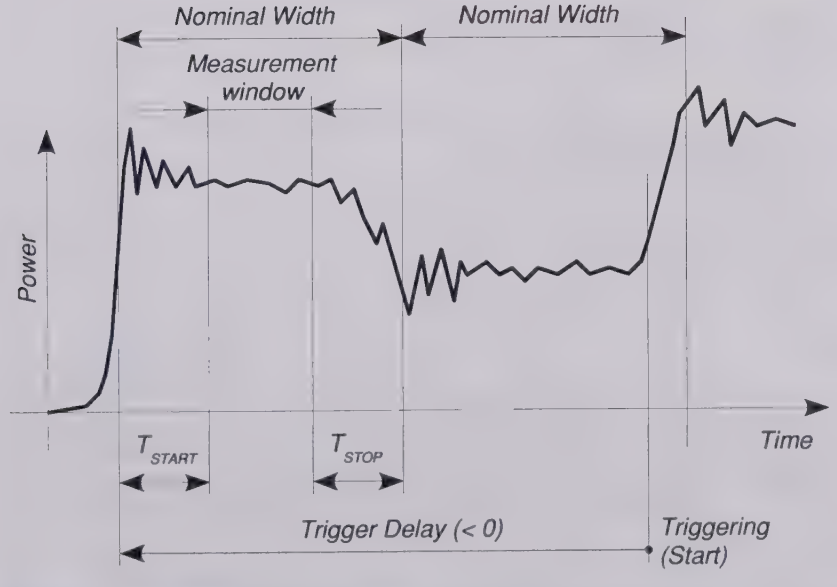

Fig. 6-3 Effect of *SENSe:TIMing:EXCLude:STARt* and *:END* in the *Timeslot* mode

SYSTem

With the aid of the SYSTem system, administrative device settings can be defined and queried. This includes detailed information on the sensor and its initialization and the transfer of available commands and their parameter limits.

Table 6-5 Commands of the *SYSTem* system

Command	Parameter	Unit	Remarks
SYSTem			
:INFO? [Item]			Query only
:INITialize			No query
MINPower?		W	Query only
:TRANsaction			
:BEGIN:			No query
:END			No query

SYSTem:INFO? [Item]

SYSTem:INFO? yields a string containing information that is more detailed than the identification string delivered by the sensor as a response to **IDN?*. If no *Item* is specified, the response string is a sequence of entries in the form *Item:Information-String* separated by *CR* and *LF* (in C notation: *\r\n*). With the *Item* optionally appended to the command, the entry for the required *Item* can be queried. The response string is zero-terminated, i.e. its end identification is a zero byte (in C notation: *\0*).

Table 6-6 Meaning of *Item* in the *SYSTem:INFO?* command

Item	Information string	Remarks
"MANUFACTURER"	"Rohde & Schwarz GmbH & Co. KG"	Manufacturer
"TYPE"	"NRP-Z11" or "NRP-Z21"	Type designation
"STOCK NUMBER"	"1138.3004.02" or "1137.6000.02"	Material number
"SERIAL"	"<serial number>"	6-digit serial number
"HWVERSION"	"000000000"	Hardware version (standard)
"HWVARIANT"	"000000000"	Hardware model (standard)
"SW BUILD"	"<build number>"	Version number of sensor firmware
"TECHNOLOGY"	"3 Path Diode"	Detector technology used
"FUNCTION"	"Power Terminating"	The R&S NRP-Z11/-Z21 is a termination power sensor.

Item	Information string	Remarks
"MINPOWER"	"<nominal lower test limit in W>"	The nominal lower test limit of the R&S NRP-Z11/-Z21 is 200 pW, i.e. with s-parameter correction deactivated, the sensor returns the information string "2e-10" as a response to *"SYSTem:INFo? "MINPOWER"*. With s-parameter correction activated, the information string depends on the nominal lower limit of the sensor/twoport combination.
"MAXPOWER"	"<nominal upper test limit in W>"	The nominal upper test limit of the R&S NRP-Z11/-Z21 is 200 mW, i.e. with s-parameter correction deactivated, the sensor returns the information string "0.2" as a response to *"SYSTem:INFo? "MAXPOWER"*. With s-parameter correction activated, the information string depends on the nominal upper limit of the sensor/twoport combination.
"MINFREQ"	"1e+07"	The minimum measuring frequency of the R&S NRP-Z11/-Z21 is 10 MHz.
"MAXFREQ"	"8e+09" or "1.8e+10"	The maximum measuring frequency is 8 GHz for the R&S NRP-Z11 and 18 GHz for the R&S NRP-Z21.
"RESOLUTION"	"2.5µs Ext, 10µs Int"	The maximum time resolution that can be reached in the Scope mode is 2.5 µs for internal triggering and 10 µs for external triggering.
"IMPEDANCE"	"50"	The R&S NRP-Z11/-Z21 RF input has a nominal input impedance of 50 Ω.
"COUPLING"	"AC/DC"	The RF input of the R&S NRP-Z11/-Z21 is DC-coupled, but DC voltages superimposed on the RF signal are suppressed by the measurement amplifier.
"CAL. ABS."	"<date>"	Date of absolute calibration in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.
"CAL. REFL."	"<date>"	Date of reflection-coefficient calibration in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.
"CAL. S PARA."	"<date>"	Date of s-parameter calibration in the format YYYY-MM-DD. If no S parameter set is loaded, the sensor returns the string "not applicable". "Invalid Calibration Date" is returned with an invalid date entry.
"CAL. MISC."	"<date>"	Date of the calibration of other parameters in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.
"SPD MNEMONIC"	"<mnemonic string>"	Clear-text designation of the components connected ahead of the sensor.

SYSTem:INITialize

SYSTem:INITialize sets the sensor to the standard state, i.e. the default settings for all test parameters are loaded in the same way as with **RST*. The sensor then outputs a complete list of all supported commands and parameters. With the command, the remote-control software can automatically adapt to the features of different types of sensors with different functionality.

SYSTem:MINPower?

SYSTem:MINPower? yields the lower test limit of the sensor or the combination comprising the sensor and components connected ahead of it, if the *SENSe:CORRection:SPDevice* parameter has the *ON* value. This query can be used to determine a useful resolution for the result display near the lower test limit.

SYSTem:TRANsaction:BEGin

SYSTEM:TRANsaction:BEGin marks the beginning of a sequence of setting commands between which the parameter limits must not be checked. This prevents the display of error messages when a setting command causes a conflict that is resolved by a subsequent setting command. See *SYSTEM:TRANsaction:END*.

SYSTem:TRANsaction:END

SYSTEM:TRANsaction:END marks the end of a sequence of setting commands between which the parameter limits must not be checked. After this command, the parameter limits are checked.

TEST

Table 6-7 Commands of the *TEST* system

Command	Parameter	Unit	Remarks
TEST:SENSor?			Query only

TEST:SENSor?

TEST:SENSor? triggers a selftest of the sensor. In contrast to **TST*, this command yields detailed information, which is useful for troubleshooting.

TRIGger

Table 6-8 Commands of the *TRIGger* system

Command	Parameter	Unit	Remarks
ABORt			No query
INITiate			
:CONTinuous[?]	OFF | ON		
:IMMediate			No query
TRIGger			
:ATRigger:STATe[?]	OFF | ON		
:COUNt[?]	1 to 2×10^9		
:DELay[?]	x to 100.0	s	
:AUTO[?]	OFF | ON		
:HOLDoff[?]	0.0 to 10.0	s	
:HYSTeresis[?]	0.0 to 3.0	dB	
:IMMediate			No query
:LEVel[?]	x to y	W	
:SLOPe[?]	POSitive | NEGative		
:SOURce[?]	BUS | EXTernal | HOLD | IMMediate | INTernal		

ABORt

ABORt interrupts the current measurement and sets the sensor to the *IDLE* state (normal case). However, if the sensor is in the continuous measurement mode (setting *INITiate:CONTinuous ON*), the *IDLE* state is immediately exited and the sensor enters the *WAIT_FOR_TRIGGER* state.

INITiate:CONTinuous[?] OFF | ON

INITiate:CONTinuous ON activates the continuous measurement mode. In this mode, a new measurement is automatically started when a measurement is terminated. The sensor first enters the *WAIT_FOR_TRIGGER* state and begins with the measurement as soon as the trigger condition is fulfilled. Once the measurement is completed, the sensor again enters the *WAIT_FOR_TRIGGER* state. The sensor will measure continuously assuming continuous trigger events.

In contrast, each measurement cycle must be explicitly started with the *INITiate:IMMediate* command after the *INITiate:CONTinuous OFF* command has been sent. After triggering and completion of the measurement, the sensor enters the *IDLE* status and remains in this status until a new measurement is started with the *INITiate:IMMediate* command.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *OFF*

INITiate:IMMediate

INITiate:IMMediate starts a single measurement cycle. The sensor first changes from the *IDLE* state to the *WAIT_FOR_TRIGGER* state and begins with the measurement as soon as the trigger condition is fulfilled. Once the measurement is completed, the sensor again enters the *IDLE* state. Since the command is ignored during measurement, it normally has no effect in the continuous mode (setting *INITiate:CONTinuous ON*).

TRIGger:ATRigger:STATe[?] OFF | ON

TRIGger:ATRigger:STATe ON causes an artificial trigger event to be triggered if no trigger is recorded more than 10 s after the measurement has been started (only in the *Scope* mode). *TRIGger:ATRigger:STATe OFF* deactivates the trigger automatic function.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *OFF*

TRIGger:COUNt[?] 1 to 2×10^9

This setting is designed for applications in which several consecutive measurements have to be performed by sending the *INITiate:IMMediate* command only once, e.g. to obtain a higher measurement speed. The gap between a single measurement and the continuous measurement mode is thus closed. The number of measurements is defined with the parameter associated with the *TRIGger:COUNt* command. This number equals the number of results yielded by the sensor at the end of the measurement.

The TRIGger:COUNt *command does not define the number of trigger events required for performing the entire measurement task. The number may vary depending on the measurement mode.*

A further increase in the measurement speed can be obtained by combining the mode used with the buffered mode. The results are not made available immediately but as a block at the end of the measurement sequence (see group commands SENSe:POWer:AVG:BUFFer).

The query yields the number of measurements performed with the *INIT:IMMediate* command after a measurement start.

Default setting: *1*

TRIGger:DELay[?] x to 100.0

TRIGger:DELay defines the delay (in seconds) between the occurrence of the trigger event and the beginning of the measurement itself for the *Timeslot* and *Scope* modes. This parameter is ignored in the *Burst Average* mode. Pretriggering is obtained by means of negative values; with bus-triggered measurements (see *TRIGger:SOURce*), the parameter must be set to positive values or zero to avoid measurement errors.

The query yields the set trigger delay for the *Timeslot* and *Scope* modes (in seconds).

Lower limit x of the parameter
Modes *Continuous Average*, *Burst Average* and *Timeslot*: x = –0.005
Mode *Scope*: x = – (<*SENSe:TRACe:OFFSet:TIME*> + 0.005)

Default setting: *0.0 [s]*

TRIGger:DELay:AUTO[?] OFF | ON

TRIGger:DELay:AUTO ON ensures by means of an automatically determined delay that a measurement is only started after the sensor has settled. This is important when thermal sensors are used. The automatically determined delay is ignored if a longer period was set with *TRIGger:DELay*. This does not overwrite the value of *TRIGger:DELay*. *TRIGger:DELay:AUTO OFF* deactivates this function.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *ON*

TRIGger:HOLDoff[?] 0.0 to 10.0

TRIGger:HOLDoff suppresses trigger events within the set holdoff time (in s), starting from the time of the last successful triggering.

The query yields the set holdoff time (in s).

Default setting: *0.0 [s]*

TRIGger:HYSTeresis[?] 0.0 to 10.0

TRIGger:HYSTeresis sets the hysteresis of the internal trigger threshold (parameter *TRIGger:LEVel*). Hysteresis is the magnitude (in dB) by which the trigger signal level falls below the trigger threshold (with positive trigger edge) to enable triggering again. The case is exactly the opposite with a negative trigger edge. The trigger hysteresis setting is only relevant to the *INTernal* trigger source.

The query yields the trigger hysteresis in dB.

Default setting: *0.0 [dB]*

TRIGger:IMMediate

TRIGger:IMMediate triggers a generic trigger event that causes the sensor to exit immediately the *WAIT_FOR_TRIGGER* state irrespective of the trigger source and the trigger delay and begin with the measurement. The command is the only means of starting a measurement when the trigger source is set to *HOLD*.

TRIGger:LEVel[?] x to y

TRIGger:LEVel sets the trigger threshold for internal triggering derived from the test signal (in W). This setting is irrelevant to all other trigger sources.

The query yields the trigger threshold in W.
Lower limit x and upper limit y of parameter

SENSe:CORRection:OFFSet:STATe OFF: x = 500 × <lower test limit>
y = <upper test limit >

SENSe:CORRection:OFFSet:STATe ON: x = 500 × < lower test limit > × 10^(<*SENSe:CORRection:OFFSet*> / 10)
y = < upper test limit > × 10^(<*SENSe:CORRection:OFFSet*> / 10)

< lower test limit >: 200.0e-12 (with *SENSe:CORRection:SPDevice:STATe OFF*) or entered lower test limit of sensor/twoport combination (with *SENSe:CORRection:SPDevice:STATe ON*)

< upper test limit >: 0.2 (with *SENSe:CORRection:SPDevice:STATe OFF*) or entered upper test limit of sensor/twoport combination (with *SENSe:CORRection:SPDevice:STATe ON*)

Default setting: 10 × x

TRIGger:SLOPe[?] POSitive | NEGative

TRIGger:SLOPe defines the edge of the trigger event with internal and external triggering in the *Timeslot* and *Scope* modes. In this connection, positive means increasing envelope power (with internal triggering) or increasing voltage (with external triggering). As in the *Burst Average* mode, this command has no effect in conjunction with trigger sources *BUS*, *HOLD* and *IMMediate*.

The query yields
- *1* for *POSitive*,
- *2* for *NEGative*.

Default setting: *POSitive*

TRIGger:SOURce[?] BUS | EXTernal | HOLD | IMMediate | INTernal

TRIGger:SOURce sets the trigger source.

- *BUS*: Triggering with command **TRG* or *TRIGger:IMMediate*.
- *EXTernal*: Triggering via USB Adapter R&S NRP-Z3. Relevant trigger parameters: *TRIGger:DELay* and *TRIGger:SLOPe*.
- *HOLD*: Triggering only with command *TRIGger:IMMediate*.
- *IMMediate*: Automatic triggering without explicit event.
- *INTernal*: Triggering by the measurement signal. Relevant trigger parameters: *TRIGger:LEVel, TRIGger:DELay* and *TRIGger:SLOPe* (not in the *Burst Average* mode).

The query yields
- *1* for *BUS*,
- *2* for *EXTernal*,
- *4* for *HOLD*,
- *8* for *IMMediate*,
- *16* for *INTernal*.

Default setting: *IMMediate*

List of Remote-Control Commands

The remote-control commands of the R&S NRP-Z11/-Z21 have a syntax based on standard SCPI 1999.0, but they comply with it only to a limited extent.

Table 6-9 List of remote-control commands

Command	Parameter	Unit	Default setting	Page
*** Commands**				
*IDN?				6.2
*RST				6.2
*TRG				6.2
*TST?				6.2
CALibration Commands				
CALibration:DATA[?]	<calibration data set as definite length block>			6.3
CALibration:DATA:LENGth?		Bytes		6.3
CALibration:ZERO:AUTO[?]	OFF | ON | ONCE		OFF (fixed)	6.4
SENSe Commands				
SENSe:AVERage:COUNt[?]	1 to 65536		4	6.7
SENSe:AVERage:COUNt:AUTO[?]	OFF | ON | ONCE		ON	6.7
SENSe:AVERage:COUNt:AUTO:MTIMe[?]	1.0 to 999.99	s	30.0	6.8
SENSe:AVERage:COUNt:AUTO:NSRatio[?]	0.0001 to 1.0	dB	0.01	6.8
SENSe:AVERage:COUNt:AUTO:RESolution[?]	1 to 4		3	6.8
SENSe:AVERage:COUNt:AUTO:SLOT[?]	1 to <SENSe:POWer:TSLot:AVG :COUNt>		1	6.8
SENSe:AVERage:COUNt:AUTO:TYPE[?]	RESolution | NSRatio		RESolution	6.9
SENSe:AVERage:RESet				6.9
SENSe:AVERage:STATe[?]	OFF | ON		ON	6.9
SENSe:AVERage:TCONtrol[?]	MOVing | REPeat		REPeat	6.9
SENSe:CORRection:DCYCle[?]	0.001 to 99.999	%	1.0	6.10
SENSe:CORRection:DCYCle:STATe[?]	OFF | ON		OFF	6.10
SENSe:CORRection:OFFSet[?]	-200.0 to 200.0	dB	0.0	6.10

Command	Parameter	Unit	Default setting	Page
SENSe:CORRection:OFFSet:STATe[?]	OFF | ON		OFF	6.10
SENSe:CORRection:SPDev:STATe[?]	OFF | ON		OFF (can be modified by the user)	6.11
SENSe:FREQuency[?]	10.0e6 to 8.0e9 (NRP-Z11) or 18.0e9 (NRP-Z21)	Hz	50.0e6	6.11
SENSe:FUNCtion[?]	"POWer:AVG" | "POWer:TSLot:AVG" | "POWer:BURSt:AVG" | "XTIMe:POWer"		"POWer:AVG"	6.12
SENSe:POWer:AVG:APERture[?]	0.0001 to 0.3	s	0.02	6.13
SENSe:POWer:AVG:BUFFer:SIZE[?]	1 to 1024		1	6.13
SENSe:POWer:AVG:BUFFer:STATe[?]	OFF | ON		OFF	6.14
SENSe:POWer:AVG:SMOothing:STATe[?]	OFF | ON		ON	6.14
SENSe:POWer:BURSt:DTOLerance[?]	0.0 to 0.003	s	0.0001	6.14
SENSe:POWer:TSLot:AVG:COUNt[?]	1 to 128		8	6.15
SENSe:POWer:TSLot:AVG:WIDTh[?]	0.0001 to 0.1	s	0.001	6.15
SENSe:RANGe[?]	0 to 2		2	6.15
SENSe:RANGe:AUTO[?]	OFF | ON		ON	6.16
SENSe:RANGe:AUTO:CLEVel[?]	–20.0 to 0.0	dB	0.0	6.16
SENSe:SAMPLING[?]	FREQ1 | FREQ2		FREQ1	6.16
SENSe:SGAMma:CORRection:STATe[?]	OFF | ON		OFF	6.16
SENSe:SGAMma:MAGNitude[?]	0.0 to 1.0		0.0	6.17
SENSe:SGAMma:PHASe[?]	–360.0 to 360.0	degree	0.0	6.17
SENSe:TRACe:AVERage:COUNt[?]	1 to 65536		4	6.17
SENSe:TRACe:AVERage:COUNt:AUTO[?]	OFF | ON | ONCE		ON	6.17
SENSe:TRACe:AVERage:COUNt:AUTO :MTIMe[?]	1.0 to 999.99	s	30.0	6.18
SENSe:TRACe:AVERage:COUNt:AUTO :NSRatio[?]	0.0001 to 1.0	dB	0.01	6.18
SENSe:TRACe:AVERage:COUNt:AUTO :POINt[?]	1 to <SENSe:TRACe:POINts>		1	6.18
SENSe:TRACe:AVERage:COUNt:AUTO :RESolution[?]	1 to 4		3	6.18
SENSe:TRACe:AVERage:COUNt:AUTO :TYPE[?]	RESolution | NSRatio		RESolution	6.19

Command	Parameter	Unit	Default setting	Page
SENSe:TRACe:AVERage:STATe[?]	OFF | ON		ON	6.19
SENSe:TRACe:AVERage:TCONtrol[?]	MOVing | REPeat		REPeat	6.19
SENSe:TRACe:MPWidth?		s		6.19
SENSe:TRACe:OFFSet:TIME[?]	– (<TRIGger:DELay> + 0.005) to 100.0	s	0.0	6.19
SENSe:TRACe:POINts[?]	1 to 1024		100	6.20
SENSe:TRACe:REALtime[?]	OFF | ON		OFF	6.20
SENSe:TRACe:TIME[?]	0.0001 to 0.3	s	0.01	6.20
SENSe:TIMing:EXCLude:STARt[?]	0.0 to 0.003	s	0.0	6.20
SENSe:TIMing:EXCLude:STOP[?]	0.0 to 0.003	s	0.0	6.20
SYSTem Commands				
SYSTem:INFO? [Item]				6.22
SYSTem:INITialize				6.23
SYSTem:MINPower?		W		6.24
SYSTem:TRANsaction:BEGin				6.23
SYSTem:TRANsaction:END				6.24
Test Commands				
TEST:SENSor?				6.25
Triggersystem Commands				
ABORt				6.26
INITiate:CONTinuous[?]	OFF | ON		OFF	6.26
INITiate:IMMediate				6.27
TRIGger:ATRigger:STATe[?]	OFF | ON		OFF	6.27
TRIGger:COUNt[?]	1 to 2×10^9		1	6.27
TRIGger:DELay[?]	x to 100.0	s	0.0	6.28
TRIGger:DELay:AUTO[?]	OFF | ON		OFF	6.28
TRIGger:HOLDoff[?]	0.0 to 10.0	s	0.0	6.28
TRIGger:HYSTeresis[?]	0.0 to 10.0	dB	0.0	6.28

Command	Parameter	Unit	Default setting	Page
TRIGger:IMMediate				6.28
TRIGger:LEVel[?]	x to y	W	1.0e-6	6.29
TRIGger:SLOPe[?]	POSitive | NEGative		POSitive	6.29
TRIGger:SOURce[?]	BUS | EXTernal | HOLD | IMMediate | INTernal		IMMediate	6.29
SERVice Commands				
SERVice:CALibration:DITHer	ONCE		OFF	
SERVice:CALibration:DITHer:DATA?			0	
SERVice:CALibration:TEMP	ONCE		OFF	
SERVice:CALibration:TEMP:DATA?		K	0.0	
SERVice:CALibration:TEST[?]			-1	
SERVice:CALibration:ZERO:NEG0?			1	
SERVice:CALibration:ZERO:POS0?			2	
SERVice:CALibration:ZERO:NEG1?			3	
SERVice:CALibration:ZERO:POS1?			4	
SERVice:CALibration:ZERO:NEG2?			5	
SERVice:CALibration:ZERO:POS2?			6	
SERVice:DITHer	OFF | ON		ON	
SERVice:MVCorrection[?]	0 to 63		63	
SERVice:PARameter:RTEMp[?]	<float value>	K	0.0	
SERVice:PARameter:RNULL0[?]	<float value>	Ω	0.0	
SERVice:PARameter:RNULL1[?]	<float value>	Ω	0.0	
SERVice:PARameter:RNULL2[?]	<float value>	Ω	0.0	
SERVice:PARameter:RBAHN[?]	<float value>	Ω	0.0	
SERVice:PARameter:NREF[?]	<float value>		0.0	
SERVice:PARameter:ATHERM[?]	<float value>	K^{-1}	0.0	
SERVice:PARameter:BTHERM[?]	<float value>	K	0.0	
SERVice:PARameter:CTHERM[?]	<float value>	K^{-1}	0.0	
SERVice:PARameter:DTHERM[?]	<float value>	K^{-1}	0.0	

Command	Parameter	Unit	Default setting	Page
SERVice:PARameter:CJUNC[?]	<float value>	F	0.0	
SERVice:RCount[?]	1 to 32767		0	
SERVice:RESult[?]	0.0 to 1.0e6	W	0.0	
SERVice:SAMPle[?]	0 to 99999999		1000	
SERVice:TDEScriptor?				
SERVice:TDEScriptor:LENGth?		Bytes		
SERVice:UNLock	1234			

ROHDE&SCHWARZ

Test and Measurement
Division

Service Instructions

1137.7406.82

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Spare Parts Express Service

Phone: +49 89 4129 - 12465

Fax: +49 89 41 29 - 13306

E-mail:werner.breidling@rsd.rohde-schwarz.com

In case of urgent spare parts requirements for this Rohde & Schwarz unit, please contact our spare parts express service.

Outside business hours, please leave us a message or send a fax or e-mail. We shall contact you promptly.

1 Performance Test

Preliminary Remarks

Verifying the data sheet specifications for the Power Sensors R&S NRP-Z11 and R&S NRP-Z21 requires a considerable amount of equipment and care. Rohde & Schwarz therefore recommends using the Power Calibration System R&S NRVC or corresponding equipment that yields the same accuracy. The tests are to be carried out directly at the manufacturer, its representatives or subsidiaries or at calibration sites that are equipped accordingly.

A **quick test** (see page 1.5) is recommended for checking the sensor with simple means.

Test Instructions

- The tests are to be performed at an ambient temperature of 20°C to 25°C. The DUT should be connected to the (activated) R&S NRP base unit for at least 30 minutes before the tests are performed.
- The test limits used in the following sections are based on the data sheet for the sensors R&S NRP-Z11 and R&S NRP-Z21. The test limits are valid only on the conditions defined in the corresponding test step. They are therefore not legally binding as accuracy specifications; only data sheet specifications are legally binding.

Measuring Equipment and Accessories

Item	Type of unit	Recommended characteristics	Recommended units	R&S order number	Application
1	Power calibration system	10 MHz to 18 GHz Calibration level 0 dBm	R&S NRVC R&S NRVC-B1 R&S SMP02 R&S NRVD	1109.0500.02 1109.1007.02 1035.5005.02 0857.8008.02	Absolute measuring accuracy
2	Linearity calibration system	-30 dBm to +23 dBm Test frequency 50 MHz	R&S NRVC-B2 R&S SMGL	1109.1207.02 1020.2005.52	Linearity
3	Network analyzer	10 MHz to 18 GHz Test port: N connector	R&S ZVM	1127.8500.60	Matching
4	Controller[1]	PC with IEC/IEEE-bus card (NI)			In connection with R&S NRVC and R&S NRVC-B2
5	Power meter	To connect the DUT	R&S NRP	1143.8500.02	Absolute measuring accuracy

1 For program-controlled calibration in connection with Calibration Kit R&S NRVC and Calibration Software *Recal*.

Performance Test with Calibration Kit NRVC and Calibration Software *Recal*

For detailed information about the performance test, refer to the operating manual for Calibration Kit R&S NRVC.

SWR measurement has to be carried out on a separate network analyzer. Evaluation is performed by Calibration Software ***Recal***.

Performance Test with Other Measuring Equipment

Checking Absolute Measuring Accuracy

The sensor contains three measurement paths. Individual calibration factors are stored for these measurement paths in the sensor. The measurement paths therefore have to be checked separately. (Table 1-1 and Table 1-2). The maximum permissible error depends on the calibration uncertainties of the sensor (Table 1-2) and the uncertainties of the calibration system. It is recommended to combine both uncertainties according to the RSS method (square root based on the sum of squares) and to use the expanded combined uncertainty as the test limit.

To calibrate measurement path 1, the measurement result of measurement path 2 can be used if the calibration system does not provide a calibration power of 10 µW or if its uncertainty is too high. In this case, only the displayed difference between the two measurement paths will be checked (Table 1-3).

Table 1-1 Calibration powers

Measurement path	Power measurement range		Calibration power
1	200 pW to 50 µW	(-67 dBm to -13 dBm)	10 µW
2	20 nW to 5 mW	(-47 dBm to +7 dBm)	1 mW
3	2 µW to 200 mW	(-27 dBm to +23 dBm)	1 mW

Table 1-2 Expanded calibration uncertainties of Sensors R&S NRP-Z11/-Z21 (in dB)

Frequency / Measurement path	10 MHz to <20 MHz	20 MHz to <100 MHz	100 MHz to 4 GHz	>4 GHz to 8 GHz	>8 GHz to 12.4 GHz	>12.4 GHz to 18 GHz
					Only R&S NRP-Z21	
1	0.056	0.056	0.066	0.083	0.094	0.123
2	0.047	0.047	0.057	0.071	0.076	0.099
3	0.048	0.047	0.057	0.072	0.076	0.099

Calibration frequencies: 10 MHz, 15 MHz, 20 MHz, 30 MHz, 50 MHz, 100 MHz; from 250 MHz to 18 GHz in 250 MHz steps.

Table 1-3 Max. measurement error (in dB) between meas. paths 1 and 2 at –20 dBm (10 µW)

Frequency	10 MHz to <20 MHz	20 MHz to <100 MHz	100 MHz to 4 GHz	>4 GHz to 8 GHz	>8 GHz to 12.4 GHz	>12.4 GHz to 18 GHz
					Only R&S NRP-Z21	
Measurement error	0.045	0.044	0.048	0.054	0.063	0.079

Procedure:

- Perform zeroing (without power applied).
- Set measurement path in ***Sensor – Range*** menu on the R&S NRP.
- Set calibration frequency in ***Frequency*** menu on the R&S NRP.
- Read power on the R&S NRP and compare with power value of calibration system. At least three measurements are recommended, with the sensor set to a different position with respect to the output connector of the calibration system each time.

Checking the Linearity

The linearity check is performed at 50 MHz with autoranging activated. The reference power is 1 mW (0 dBm). The maximum permissible linearity error depends on the linearity uncertainty of the sensor (Table 1-4) and the linearity uncertainty of the calibration system. It is recommended to combine both uncertainties according to the RSS method (square root based on the sum of squares) and to use the expanded combined uncertainty as the test limit.

Table 1-4 Expanded linearity uncertainties of Sensors R&S NRP-Z11 and R&S NRP-Z21 at 50 MHz (in dB, with reference to 0 dBm)

Test level	-30 dBm to -13 dBm	-13 dBm to +1 dBm	+1 dBm to +23 dBm
Uncertainty	0.044	0.022	0.044

Calibration levels: -30 dBm, -25 dBm, -20 dBm, -15 dBm, -10 dBm, -5 dBm, 0 dBm, +5 dBm, +10 dBm, +15 dBm, +20 dBm, +23 dBm

Procedure:

- Perform zeroing (without power applied).
- Set autoranging in ***Sensor – Range*** menu on the R&S NRP.
- Set 50 MHz in ***Frequency*** menu on the R&S NRP.
- Apply level of 0 dBm and activate ***Relative On*** in the ***Measurement*** menu on the R&S NRP. Use the current measurement value as the reference value (***Reset***). Set unit to ***dB***.
- Set the calibration level and compare the relative level measured by the R&S NRP with that of the calibration system.

Checking Matching

For these measurements, the sensor can be operated with or without the R&S NRP base unit. The measurement procedure depends on the network analyzer used.

Table 1-5 Max. SWR of Sensors R&S NRP-Z11 and R&S NRP-Z21

Frequency	10 MHz to <30 MHz	30 MHz to 2.4 GHz	>2.4 GHz to 8 GHz	>8 GHz to 12.4 GHz	>12.4 GHz to 18 GHz
				Only R&S NRP-Z21	
Max. SWR	1.13	1.11	1.18	1.23	1.23

Quick Test

The following tests are used to check the R&S NRP-Z11 and R&S NRP-Z21 with simple means. If the tests are passed, compliance of the sensors with the specifications within the complete frequency and power range is largely ensured.

The test consists of:

- Zeroing.
- Absolute measuring accuracy at 0 dBm (50 MHz).
- Linearity when changing the measurement path (50 MHz).
- Input resistance (for DC voltage/current).

Test Instructions

- The tests are to be performed at an ambient temperature of 15°C to 35°C. The DUT should be connected to the (activated) R&S NRP base unit for at least 30 minutes before the tests are performed.
- The test limits used in the following sections are based on the data sheet but are valid only on the conditions defined for the corresponding test step. They are therefore not binding as far as accuracy is concerned but are strictly data sheet information.
- The entries made on the Power Meter R&S NRP are abbreviated as follows:

  [**<KEY>**] Press front-panel key, e.g. **[FREQ]**.

  [<SOFTKEY>] Press softkey, e.g. [Range].

  [<**nn unit**>] Enter value and confirm with unit, e.g. [**3 GHz**].

  Successive entries are separated by [:], e.g. [**FREQ** : **3 GHz**].

Measuring Equipment and Accessories Required for the Quick Test

Item	Type of unit	Recommended characteristics	Recommended units	R&S order number	Application
1	Power meter	For connecting the DUT with power reference 1 mW / 50 MHz Expanded uncertainty <1.2 %	R&S NRP R&S NRP-B1	1143.8500.02 1146.9008.02	Absolute measuring accuracy Linearity
2	Signal generator	50 MHz Output level -20 dBm ... 0 dBm	R&S SML01	1090.3000.11	Linearity
3	System voltmeter	4-wire resistance measurement at 50 Ω Expanded measurement uncertainty <0.2 Ω			Input resistance
4	Adapter	BNC (plug) to 4-mm sockets (2-pin).		0017.6742.00	Input resistance
5	Adapter	BNC (socket) to N (socket).			Input resistance

Checking Zeroing

Test setup

- Sensor (DUT) is connected to power reference output of power meter (1).
- Power reference is switched off.

Settings on R&S NRP

- [(**PRE)SET: (PRE)SET**]
- [**ZERO/CAL: ZERO/CAL**]

Test

- Message "Zeroing A(B) successful".
- Display value is within limits of test report.

Checking the Absolute Measuring Accuracy

Test setup	- Sensor (DUT) is connected to power reference output.
	- Power reference is switched off.
Setting on R&S NRP	- [**(PRE)SET: (PRE)SET:** System: Power Ref On]
Test	- Display value is within the limits of test report.

Checking the Linearity

Test setup	- Sensor is connected to signal generator output
Setting on signal generator	- Frequency 50 MHz, output level -20 dBm, unmodulated.
Setting on R&S NRP	- [**(PRE)SET**: **(PRE)SET**: Sensor: Range: Auto □: Path 1]
Measurement	- On R&S NRP, approx. -20 dBm must be displayed.
Setting on R&S NRP	- [Measurement: Relative On: Reset]
Measurement	- On R&S NRP, 0.00 dB must be displayed.
Setting on R&S NRP	- [Sensor: Range: Auto □: Path 2]
Test	- Displayed value is within limits of Performance Test Report.
Setting on signal generator	- Frequency 50 MHz, output level 0 dBm, unmodulated.
Setting on R&S NRP	- [Sensor: Range: Auto □: Path 2]
Measurement	- On R&S NRP, approx. 0 dBm must be displayed.
Setting on R&S NRP	- [Measurement: Relative On: Reset]
Measurement	- On R&S NRP, 0.00 dB must be displayed.
Setting on R&S NRP	- [Sensor: Range: Auto □: Path 3]
Test	- Displayed value is within limits of Performance Test Report.

Checking Input Resistance

Test setup

- System voltmeter is set to 4-wire impedance measurement and is connected to DUT according to figure.

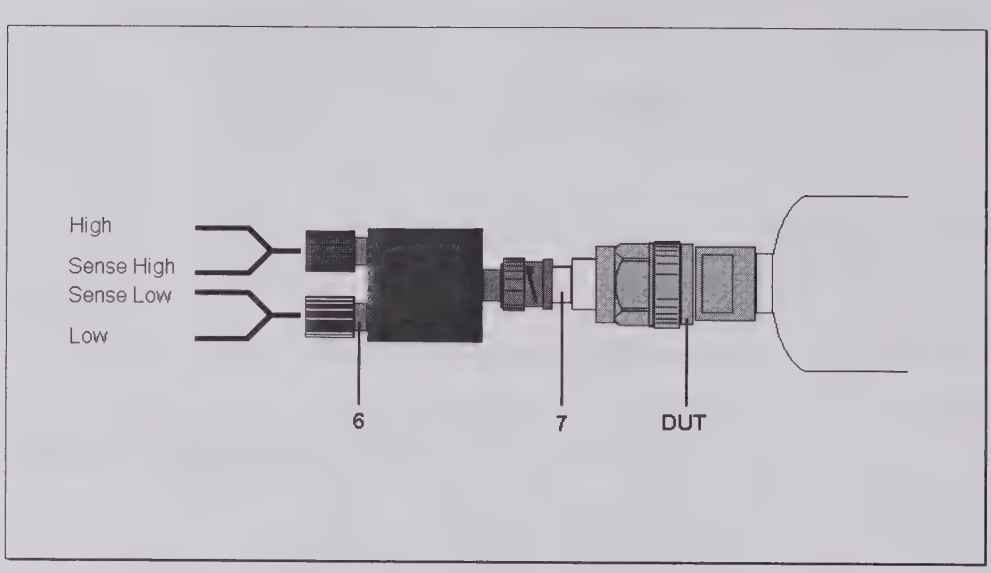


Fig. 1-1 Connection of DUT for measuring the input resistance

Test

- Check input resistance of sensor for compliance with limits of test report.

Test Report

Quick test

Power Sensor R&S NRP-Z11

Stock number: 1138.3004.02 Name: .....

Serial number: ..... Date: .....

Item no.	Characteristic	Min. value	Actual value	Max. value	Unit
1	Zeroing	-------		-67.0	dBm
2	Absolute measuring accur. at 0 dBm / 50 MHz	-0.10		+0.10	dBm
3	Linear. of meas. path 1 → 2	-0.10		+0.10	dB
4	Linear. of meas. path 2 → 3	-0.10		+0.10	dB
5	Input resistance	50.2		51.8	Ω

Quick test

Power Sensor R&S NRP-Z21

Stock number: 1137.6000.02 Name: .....

Serial number: ..... Date: .....

Item no.	Characteristic	Min. value	Actual value	Max. value	Unit
6	Zeroing	-------		-67.0	dBm
7	Absolute measuring accur. at 0 dBm / 50 MHz	-0.10		+0.10	dBm
8	Linear. of meas. path 1 → 2	-0.10		+0.10	dB
9	Linear. of meas. path 2 → 3	-0.10		+0.10	dB
10	Input resistance	50.2		51.8	Ω

2 Adjustment

Preliminary Remarks

The Sensors R&S NRP-Z11 and R&S NRP-Z21 cannot be adjusted manually but have to be adjusted by updating the calibration data in the memory. Calibration Software ***Recal***, which is part of the equipment supplied with the Calibration Kit R&S NRVC, is therefore required. The measurement results for the absolute calibration of the three measurement paths which can be obtained during a performance test (see Section 1) form the basis of the adjustment. The Calibration Kit R&S NRVC is recommended but is not mandatory.

To ensure that the measuring accuracy corresponds to the data sheet values after the adjustment, the calibration system must not have any inaccuracies that are higher than those given in the table below.

Table 2-1 Uncertainty of power calibration system at 0 dBm (in dB, including mismatch)

Frequency	10 MHz to <20 MHz	20 MHz to <100 MHz	100 MHz to 4 GHz	>4 GHz to 8 GHz	>8 GHz to 12.4 GHz	>12.4 GHz to 18 GHz
					Only R&S NRP-Z21	
	0.04	0.04	0.05	0.065	0.07	0.09

For further details, refer to the operating manual for the Calibration Kit R&S NRVC or the online help for the ***Recal*** program.

3 Repair of Sensors R&S NRP-Z11/-Z21

This section describes the design and simple measures for repairing and determining faults as well as the replacement of modules.

The firmware update is explained in section 4 of this service manual.

Design and Circuit Description

Block Diagram

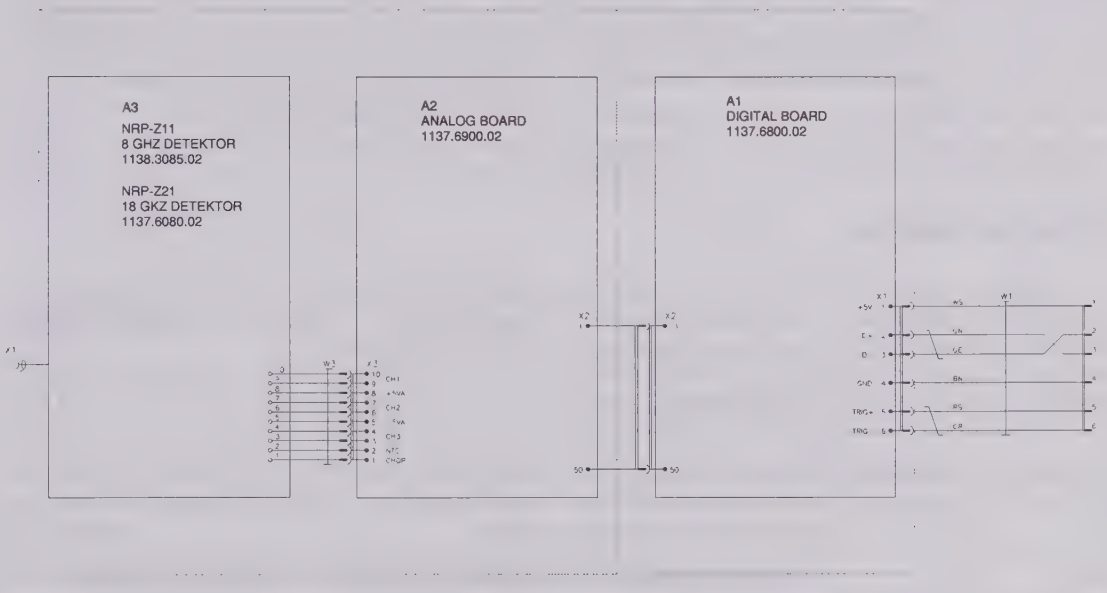


Fig. 3-1 Block diagram of Sensors R&S NRP-Z11 and R&S NRP-Z21

Description of Block Diagram

The Sensors R&S NRP-Z11 and R&S NRP-Z21 can determine the average power of almost any modulated RF signal over a large dynamic range. They include all modules required for analog and digital signal processing and provide fully corrected measured values. Communication with the R&S NRP base unit is handled via a USB interface.

Three detectors are used to obtain the large dynamic range of 90 dB (–67 dBm to +23 dBm); the input signal is fed unattenuated to path 1, attenuated by 20 dB to path 2 and attenuated by 40 dB to path 3. Sensitivity is highest on path 1, medium on path 2 and lowest on path 3.

Depending on the RF input signal level, one or two test paths are driven at such a level that these paths can be evaluated. A channel is always either driven at a very low level or overdriven. The output voltages of the three detectors are amplified and digitized independently of each other to obtain a continuous transition between the test paths. The digital values provided by the A/D converters undergo various corrections (zero offset, temperature, linearity). A weighting algorithm then decides which path or – in transition ranges – which two paths are to be evaluated, and forms a weighted measured value. Integration values that represent the average power of the RF signal in a predefined integration period are derived by averaging all sampling values within the integration period.

The final measured values are the averaged result from several integration values.

Microwave Detector

The microwave detector A3 is a hybrid circuit. It contains the three test paths and a thermistor for temperature measurement. The detector has an RF signal input and a flexstrip connector for output signals, control signals and operating voltages with the following assignment:

Table 3-1 Assignment of flexstrip connector W3

Connector	Signal name	Description
W3:1	CHOP	Logic signal for controlling the choppers
W3:2	NTC	Thermistor connector (the other connector of the thermistor is connected to ground)
W3:3 W3:4	CH3	Output of the most insensitive test path
W3:5	–5VA	Negative operating voltage for the choppers
W3:6 W3:7	CH2	Output of the medium test path
W3:8	+5VA	Positive operating voltage for the choppers
W3:9 W3:10	CH1	Output of the most sensitive test path

The casing of the detector is at ground potential.

Analog Board

The analog board A2 contains three test channels of the same design, each consisting of an instrumentation amplifier, a buffer amplifier and a 14-bit A/D converter. The instrumentation amplifiers amplify the output difference voltage of the detectors and convert it into a ground-referenced voltage. The buffer amplifiers are quickly settling operational amplifiers with negative current feedback; they isolate the instrumentation amplifiers from the current peaks occurring at the A/D converter inputs. The A/D converters operate on the successive approximation principle. They have serial outputs.

The serial output data streams of the A/D converters are subjected to serial-parallel conversion in a CPLD and stored in three addressable registers. The digital board consecutively addresses and reads out these registers.
The analog board also comprises an 8-bit D/A converter for generating a noise-line large-scale dither signal that is controlled by the digital board with a sequence of pseudo-random digital values.

The analog board contains a four-channel 12-bit A/D converter for measuring the substrate temperature of the detector as well as for monitoring the operating voltages ±5 V and +1.75 V. The 12-bit A/D converter is supplied by the 3.3 V operating voltage of the digital board and is thus operational even if the voltage supply of the analog board is defective. It is connected to the synchronous serial interface of the digital board and utilizes the MICROWIRE™ protocol.

The +5 V operating voltage of the analog board is generated from +3.3 V by a charge pump doubler with subsequent linear regulator. The 5 V operating voltage is generated by a switching regulator with a very low output ripple voltage.

Digital Board

The digital board A1 mainly consists of a controller based on a microcontroller Intel StrongARM SA1110, two SRAMs (together 1 Mbyte) as random access memory and two flash PROMs (together 2 Mbyte).

The interface to the R&S NRP base unit is formed by connector X1 on the digital board. Besides the four lines for the USB interface, the sensor cable contains two signal lines for applying a differential trigger signal.

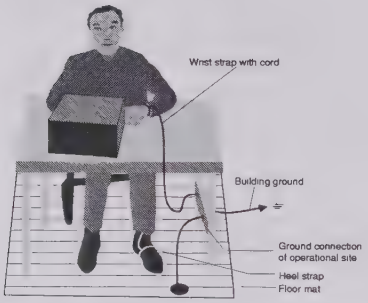
The connection to the analog board is established by press-in connector X2.

The digital board contains two DC/DC converters that generate the voltages +3.3 V and +1.75 V (for the microcontroller core) from the +5 V operating voltage.

Module Replacement

The following section describes how to exchange the plastic shell halves and how to replace the connecting cable. If one of the electronic modules (microwave detector, analog board or digital board) is defective, the sensor has to be sent to Rohde & Schwarz Central Service for repair.

Caution!



- *Observe the safety instructions at the beginning of this manual.*
- *To avoid damaging electronic components, the instrument should only be opened on a workplace protected against electrostatic discharges.*

  The following methods can be used separately or combined to ensure protection against electrostatic discharges:
- *Anti-static wrist strap with grounding cable.*
- *Conductive flooring with foot strap.*

Tools Required

Torx screwdriver	Size	T8
	Thread	M 2.5

Note:

The numeric values in brackets refer to the item in the list of mechanical parts and spare parts in section 5.

These items are identical to the item numbers in the drawings illustrating the module replacement.

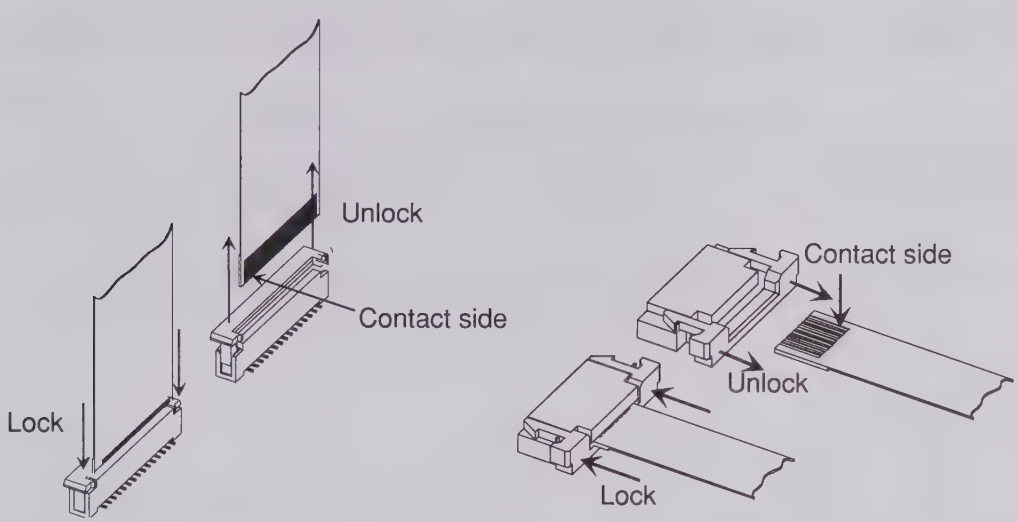


Fig. 3-2 Membrane cables

Note:

Remove membrane cables:
Membrane cables can be removed after unlocking the female connector.
Connect membrane cables:
Observe the contact side and lock the female connector.

List of Modules

Table 3-2 List of modules/spare parts for R&S NRP-Z11 and R&S NRP-Z21

Item No.	Designation	Electrical identification	Stock No.
20	ANALOG BOARD	A2	**)
40	POWER SENSOR CABLE	W1	1137.7141.02
60	SCREW 7985/ISR-M2X8-A4 FOR POWER SENSOR CABLE W1		1148.2600.00 *)
80	DIGITAL BOARD	A1	**)
90	SCREW 7985/ISR-M2X10-A4 FOR DIGITAL BOARD A1		1148.2917.00 *)
100	18 GHZ DETECTOR (NRP-Z21)	A3	**)
101	8 GHZ DETECTOR (NRP-Z11)	A3	**)
150	SHIELDING		1137.6068.00 *)
160	SENSOR HOUSING		1137.6022.00
170	SCREW 7985/ISR-M2X8-A4 FOR OUTER CASING		1148.2600.00 *)
180	LABEL 1 R&S NRP-Z11		1138.3033.00
190	LABEL 2 R&S NRP-Z11		1138.3040.00
200	LABEL 1 R&S NRP-Z21		1137.6039.00
210	LABEL 2 R&S NRP-Z21		1137.6045.00

*) Available but not maintained in spare parts stock, i.e. delivery time may be longer.
**) Spare part not available; to be replaced only by Rohde & Schwarz Central Service.

Opening and Reassembly (Exchange of Plastic Shell Halves)

Opening

- Undo two screws (170) on the two sides of the cable connector.
- First pull off the plastic shell halves of the cable connector and take them apart by twisting them at the RF connector.
- The shielding is attached by a catch of the body on the RF connector side. Slightly bend and unlock the shielding by firmly pressing on the two slim sides and pull it off in the cable direction.

Reassembly

- Push the shielding and lock it into the catch of the body.
- Insert the sensor into one of the shell halves and lock the second shell half on the RF connector side and close at the cable connector.
- Attach the shell halves to the body using two screws (170).

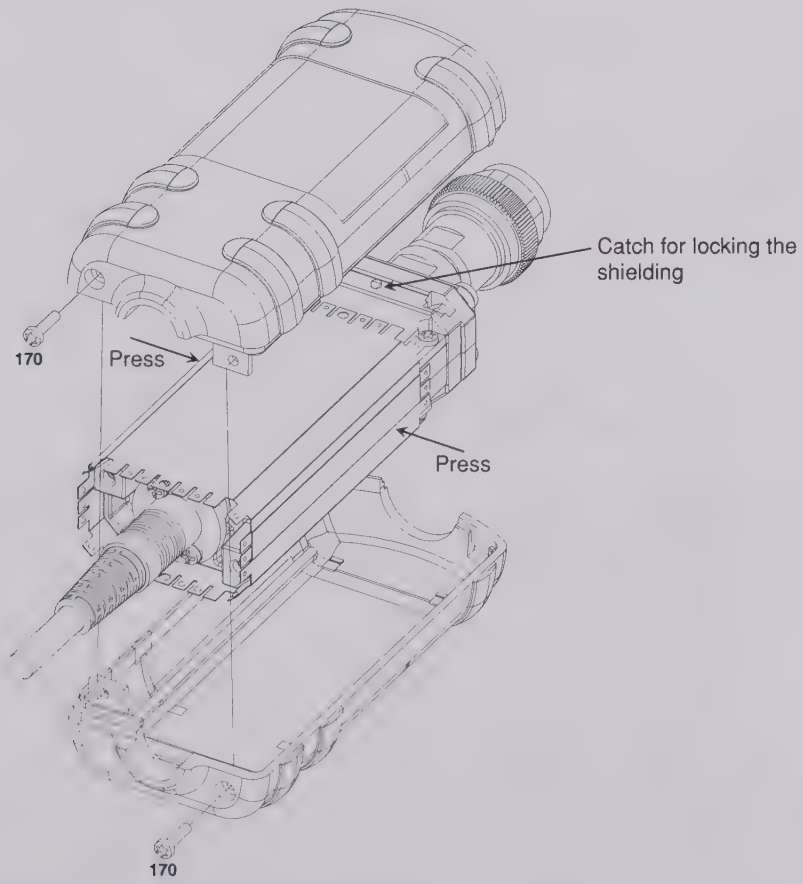


Fig. 3-3 Opening the sensor

Caution:

Observe a torque of 29 Ncm for all screws.

Replacement of Sensor Cable W1

Removing the Sensor Cable

- Opening the sensor (see page 3.7).
- Undo 6 screws (90).
- Carefully remove digital board A1 from the body.
- Unplug sensor cable W1 from digital board.
- For removing sensor cable W1, undo two screws (60) and remove the cable from the body.

Installing the Sensor Cable

- Install in the reverse order.
- Ensure that the guide pins of press-in connector X2 lock into the corresponding boreholes of the digital board.

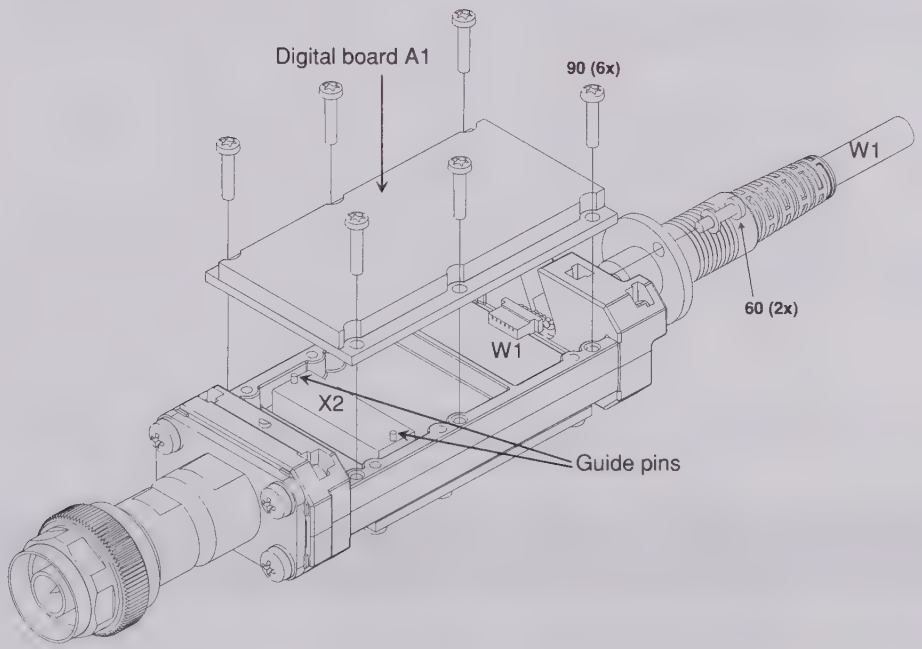


Fig. 3-4 Replacement of sensor cable

Troubleshooting

Malfunctions may sometimes be due to simple reasons but may also result from defective components.

These troubleshooting instructions permit malfunctions or errors to be traced down to module level.

Module replacement and further diagnosis of errors or malfunctions should be carried out by our customer service. It is therefore recommended to send the unit to the nearest service center (see list of addresses at the beginning of this manual).

Caution:

Prior to opening sensor and replacing modules, disconnect sensor from base unit (R&S NRP) or USB adapters (R&S NRP-Z3 or R&S NRP-Z4).

Overview of Errors, Causes and Corrective Steps

This section provides an overview of possible errors, their causes and corrective steps.

Problems when plugging in the sensor or switching on the R&S NRP base unit

- **Error: The power sensor is not found (neither measured values nor error messages are displayed on the R&S NRP base unit).**

Troubleshooting instruction	Potential error source and further corrective steps
Unplug sensor from base unit and check male and female connector for damage.	Defective connection. *Replace the sensor cable and/or the connector in the R&S NRP.*
⇓	
Check whether the error also occurs on another base unit or in another channel.	Error source within base unit. *Refer to chapter 3 of the R&S NRP service manual for detailed troubleshooting.*
	Error source within sensor. Open sensor and check connection of sensor cable W1 with digital board. *Exchange sensor cable.* *Send sensor in for repair (digital board possibly defective).*

- **Error: The R&S NRP base unit has detected an error (pop-up window contains error message, e.g. *Sensor communication error*).**

Troubleshooting instruction	Potential error source and further corrective steps
	Base unit and sensor cannot communicate with each other. The firmware versions may not be compatible.
⇓	
Load current firmware into sensor and base unit according to section 4.	*If updated firmware does not correct problem, perform the same measures as described above (sensor is not found).*

- **Error: The power sensor has detected an error (*HW Error* displayed at extreme right of title bar).**

Troubleshooting instruction	Potential error source and further corrective steps
	The sensor detected an error during selfttest or during communication (hardware defect or defective voltage supply).
⇓	
Check whether error also occurs on a different base unit.	Error source within base unit. *Refer to chapter 3 of the R&S NRP service manual for detailed troubleshooting.*
	Error source within sensor. *Send sensor in for repair (analog board or digital board is defective).*

Problems during measurement

- **Error: Measured power readings are erroneous.**

Troubleshooting instruction	Potential error source and further corrective steps
Perform performance test or selftest according to section 1.	Sensor was overloaded: indicated by very poor matching and/or errors in measurement path 1. *Send sensor in for repair (microwave detector is defective).* Other parts of sensor hardware are defective. *Send sensor in for repair (microwave detector or analog board is defective).* Sensor hardware is probably ok since test limits are only slightly exceeded. *Perform update of calibration factors in data memory of sensor according to section 2.*

4 Firmware Update/Installation of Options

Chapter 4 provides information on the software update and the installation of options. Descriptions enclosed with the software update or options can be filed here.

Installation of New R&S NRP-Z11/-Z21 Software

Use the Firmware Update program module to load new firmware for the Power Sensors R&S NRP-Z11 and NRP-Z21. The module is part of the R&S NRP Toolkit that is supplied on a CD-ROM together with the power sensors and enables you to update the boot loader and the application firmware.

The current firmware versions can be downloaded from the R&S homepage on the Internet, since the CD-ROM accompanying the power sensors contains the firmware status at the time of delivery.

Hardware and software requirements

The system requirements for a firmware update are the same as for the operation of the power sensor on a PC (an update via the power meter is not possible):

- PC with free USB port.
- USB Interface Adapter R&S NRP-Z3 or R&S NRP-Z4.
- Operating system Windows™ 98, Windows™ ME, Windows™ 2000, or Windows™ XP.
- **The R&S NRP Toolkit software must already be installed on your PC.**
- One of the following files must be selected (depending on the software component to be updated):
  - `<Type>_Sensor<Version Number>.nrp` Application
  - `Bootloader_<Version Number>.nrp,` Boot loader

  The files are available in the \software\firmware\sensors directory of the CD-ROM.

Preparation

- Connect the R&S NRP power sensor to the PC using one of the two USB interface adapters.
- If a second R&S NRP-Z power sensor or an R&S NRP is connected to the PC, unplug these devices from the PC.
- Shortly afterwards, the PC should have identified the new USB hardware and assigned the appropriate driver from the **R&S NRP Toolkit** to the power sensor (brief message in a small window).

If you forgot to install the R&S NRP Toolkit beforehand, Windows will try in vain to find a USB driver for the power sensor. If this happens, the R&S NRP-Zxx is highlighted by a yellow exclamation mark in the Windows device manager. In this case, proceed as follows:

- *Abort the dialog for driver installation.*
- *Install the R&S NRP Toolkit from the CD-ROM.*
  Then manually assign the USB driver from the toolkit to the power sensor.
- *Go to Control Panel – Add/Remove Hardware and start the hardware assistant to search for new components.*
- *Mark the R&S NRP-Zxx in the list of hardware components and complete the driver installation.*
- *Unplug the power sensor and reconnect it.*

Updating the application firmware

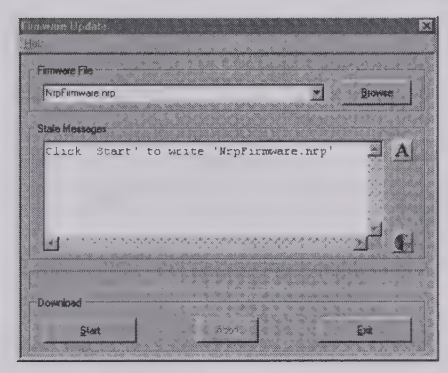
NRP_Z21_Messkopf_01_15.nrp

The update can be started as follows:

➢ Either double-click the icon of the update file named `<Type>_Messkopf_<Version Number>.nrp`

➢ Or start **NRP Toolkit – Firmware Update** from the Windows Start menu.

The dialog box on the left is displayed next.

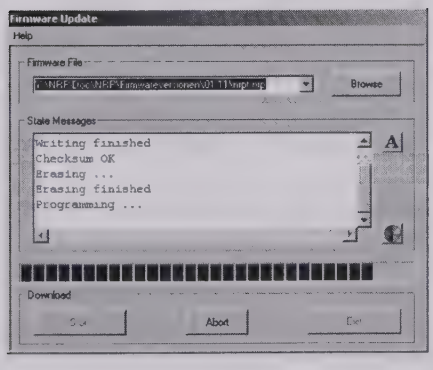


➢ If the update was started via the Windows Start menu, enter the file name of the application firmware in the **Firmware File** box (or search for the name by using the **Browse** button).

➢ Click the **Start** button to start the file transfer, which is performed automatically.

➢ Observe the following:

- *Do not disconnect the power sensor from the PC.*
- *Neither connect nor disconnect the power supply for the R&S NRP-Z3 adapter.*
- *Exit the Firmware Update program only after it has been completely executed.*



➢ During the update, the State Messages box informs you of the progress. The update has been completed successfully if the message `'Device <Type Designation><Serial Number> is active'` appears.

➢ You can then use the power sensor for measuring.

Potential problems

- Error in the compatibility and consistency checks.

  In this case, the update is aborted and an error message is output.

➢ Unplug the power sensor, reconnect it and start the update again.

Updating the boot loader

Bootloader_00_20.nrp

The boot loader update is similar to the update of the application firmware (see above).

➢ Instead of the application, however, you must load the new boot loader named

`Bootloader_<Version Number>.nrp`

Strictly observe the warnings under "Updating the application firmware", since the destruction of the boot loader will generally require a repair of the power sensor.

Potential problems

- The power sensor cannot be accessed after the update (error message).

➢ Exit the Firmware Update program, unplug the power sensor from the PC and reconnect it. The power sensor is now ready for operation.

5 Documents

This section provides information for ordering spare parts and contains the relevant documents for the Rohde & Schwarz Power Sensors R&S NRP-Z11 and R&S NRP-Z21.

Shipping of Instrument and Ordering of Spare Parts

Please contact your Rohde & Schwarz support center or our spare parts express service if you need to request service, repair your equipment, or order spare parts and modules.

The list of Rohde & Schwarz representatives and the address of our spare parts express service are provided in the front section of this service manual.

You will need to provide the following information in order for us to respond to your inquiries quickly and accurately and to determine whether the warranty for your instrument is still valid:

- Instrument model
- Serial number
- Detailed error description in case of repair
- Contact partner for checkbacks

Shipping of Instrument

When shipping the instrument, be sure to provide sufficient mechanical and anti-static protection:

➢ Repack the instrument as it was originally packed. The antistatic packing foil prevents unintentional electrostatic charging from occurring.

➢ If you do not use the original packaging, include sufficient padding to prevent the instrument from slipping inside the package. Wrap antistatic packing foil around the instrument to protect it from electrostatic charging.

Ordering Spare Parts

To deliver replacement parts promptly and correctly, we need the following information:

- R&S stock number (refer to the spare part lists in this section)
- Designation
- Number of units
- Instrument type for the replacement part
- Contact person for possible questions

The R&S stock number to be used when ordering replacement parts and modules as well as power cables can be found further below.

Ordering Replacement Sensors

Rohde & Schwarz maintains a replacement program for a number of power sensors. Within this program, it is possible to provide a fully operational power sensor to replace a defective one at short notice and at a fixed price. Please note that replacement sensors are used equipment but are always tested. They are therefore equivalent to new sensors even though they may exhibit slight signs of use. If required, the delivery of replacement sensors can include a new calibration. If interested, please contact your nearest Rohde & Schwarz office.

Spare Parts

The R&S stock numbers necessary for ordering replacement parts and modules can be found in the spare part lists provided below.

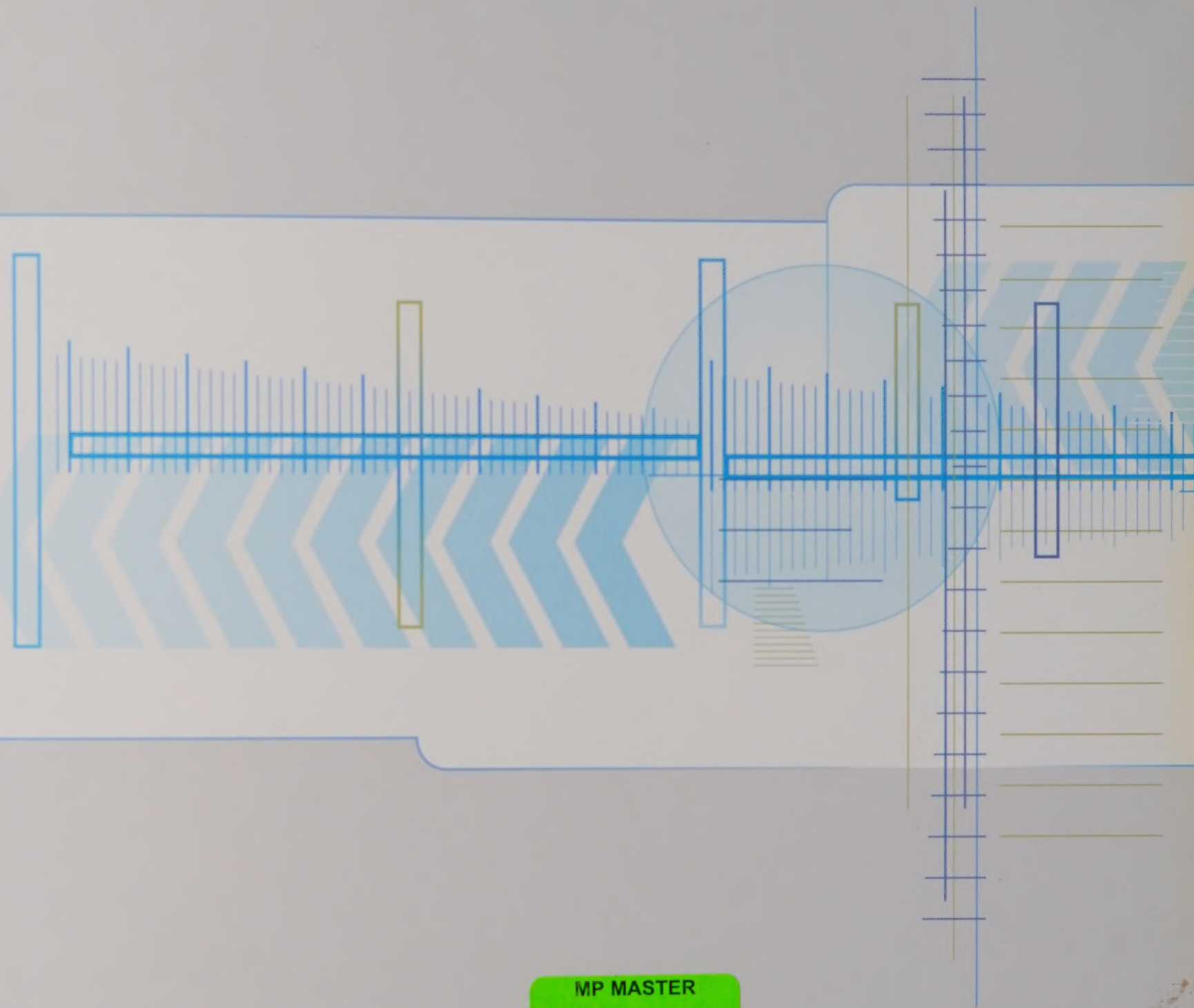
List of R&S NRP-Z11/-Z21 Spare Parts

The following table lists available spare parts together with their R&S stock numbers.

Item No.	Designation	Electrical identification	Stock No.
20	ANALOG BOARD	A2	**)
40	POWER SENSOR CABLE	W1	1137.7141.02
60	SCREW 7985/ISR-M2X8-A4 FOR POWER SENSOR CABLE W1		1148.2600.00 *)
80	DIGITAL BOARD	A1	**)
90	SCREW 7985/ISR-M2X10-A4 FOR DIGITAL BOARD A1		1148.2917.00 *)
100	18 GHZ DETECTOR (NRP-Z21)	A3	**)
101	8 GHZ DETECTOR (NRP-Z11)	A3	**)
150	SHIELDING		1137.6068.00 *)
160	SENSOR HOUSING		1137.6022.00
170	SCREW 7985/ISR-M2X8-A4 FOR OUTER CASING		1148.2600.00 *)
180	LABEL 1 R&S NRP-Z11		1138.3033.00
190	LABEL 2 R&S NRP-Z11		1138.3040.00
200	LABEL 1 R&S NRP-Z21		1137.6039.00
210	LABEL 2 R&S NRP-Z21		1137.6045.00

Note: *The reference can be found in the drawings 3-3 and 3-4 in Section 3.*

*) Available but not maintained in spare parts stock, i.e. delivery time may be longer.
**) Spare part not available; to be replaced only by Rohde & Schwarz Central Service.



MP MASTER
MA34500

ROHDE&SCHWARZ